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Ratoon Stunting Disease

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[Wh]at is Ratoon Stunting Disease ?

In January, 1945, reports came in that Q.28 was not ratooning as well as might be expected in some plantings in the Walkerston-Rosella area in the Mackay district. The plant crop had in all instances been satisfactory or reasonably so, but when it was noted that some crops cut in September, 1944, had not made any growth by the following January, some concern was felt. The spring months had been very dry and the rainfall for August to December inclusive was only four and a half inches compared with the usual fourteen. Nevertheless this did not appear to be sufficient reason for some ratoons remaining so backward that even after four months they still appeared as though cut only a few weeks before, especially since Q.28 was proving itself one of the most vigorous canes ever cultivated in Mackay. The variety had just yielded ten per cent. of the Mackay crop and fully deserved its important position in the planting programme. Some magnificent crops had been harvested and until this very dry spring occurred there had been no suspicion that Q.28 was anything but a vigorous ratooner. On looking through the records one finds that this spring of 1944 was the first abnormally dry one since Q.28 had become a commercial variety; it is now known that drought conditions are important predisposing factors in the expression of the disease and it is fortunate from the investigational angle that this dry spell was felt in 1944-1945. Had this drought occurred some years previously when Q.28 was only an advanced seedling and not a commercial cane, and had the variety already been diseased it would have joined the hundreds of seedlings which just do not make the grade; had it been some years later the opinion would have been that the loss of yield was due to varietal deterioration or running-out, a subject which has always intrigued the farmer and the agriculturist alike.

Ratoon stunting is not an easy disease to investigate. There are no easily identifiable external symptoms except the severe stunting, which itself may be masked by good growing conditions or tolerance of a variety, or may be explained on the basis of some other influence. Obvious features such as streaks, spots and other leaf markings are absent and the death which may result under certain conditions does not differ from that due to dozens of other causes. It has been found within the last year or so that certain internal

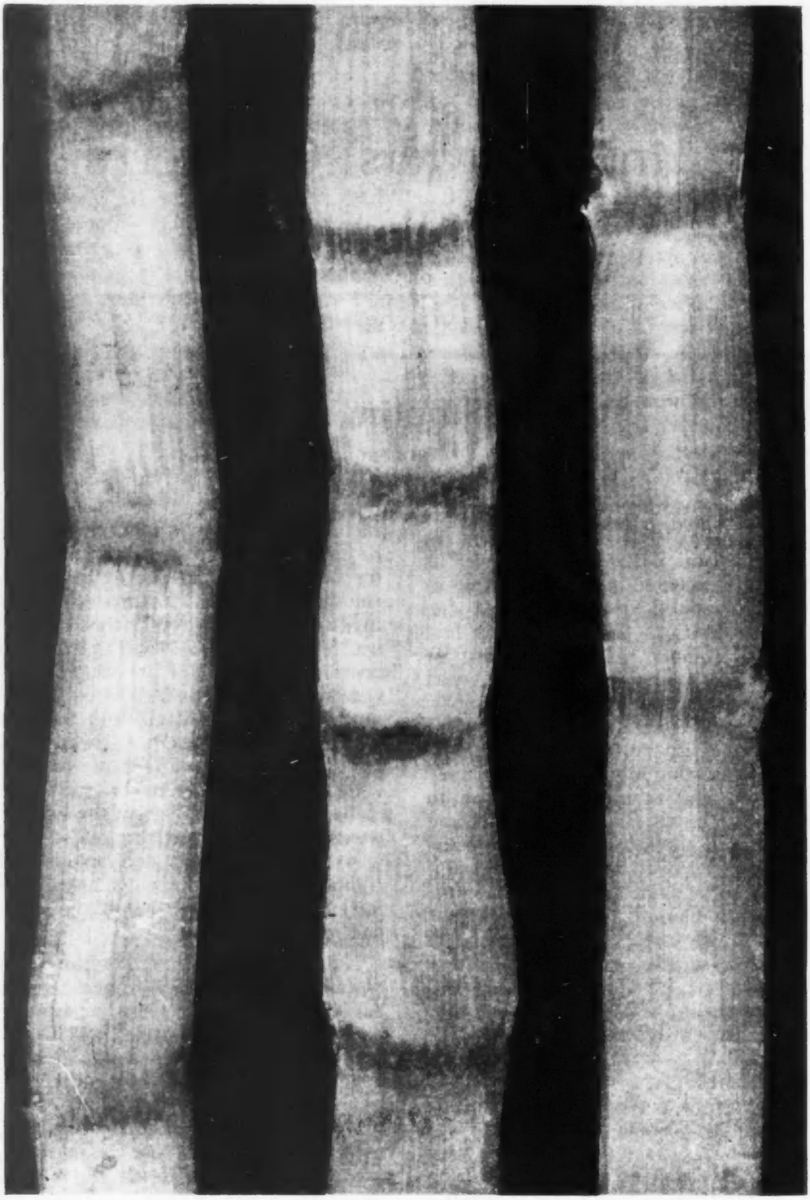


Fig. 35 Cane stalks split lengthwise showing discoloured vascular bundles at the nodes. Two stalks on left are diseased, stalk on right healthy.

symptoms are indicative of ratoon stunting disease, but the first investigations did not have the advantage of this knowledge and the outlook for a solution of the problem was not particularly bright. One interesting early observation was that setts obtained from different sources varied in yield in the subsequent ratoon crops. Some farmers suggested that two varieties might be involved, one that ratooned normally and one that did not, although they were indistinguishable in the plant crop. This view was not held by the Bureau and investigations were commenced on the assumption that a disease causing agent was involved.

At first the only variety which appeared to be affected was Q.28, and the disease was popularly referred to as "Q.28 disease." It was considered undesirable to perpetuate such a name and the Bureau's annual report for 1948-1949 contains the first published reference to the disease as "ratoon stunting." The term is descriptive to the extent that the chief and most obvious symptom of the disease is the stunting of the ratoons.

Some preliminary trials were initiated in the planting season of 1945, but it was not until 1947 that it was possible to set out large-scale experiments. Since that date, despite loss of plantings by flood and dry weather, knowledge of the disease has increased year by year, so that now we know that it is an easily transmissible disease and that it occurs in every mill area in the State and may occur in some overseas, cane producing countries.

Fig. 36—A field of young ratoon Q.28 with two rows of diseased cane in an otherwise healthy stand

Symptoms of the Disease.

The chief symptoms are a stunting of the cane, particularly in the ratoons, and a discolouration of the vascular bundles at certain points inside the stem. The stunting or reduction in growth is not very obvious in the plant crop although trials have shown that crops from healthy planting material will yield more heavily than those from diseased setts. A series of trials with

Q.28 in the Mackay district, in which the diseased and healthy plots were replicated a suitable number of times to ensure that the results would be reliable, showed that losses of up to ten tons per acre could result in a plant crop (*see* Table I). These trials were planted in 1947 and the rainfall was much less than normal during the spring and early summer, but a small loss in plant crops is apparently the normal reaction to the disease. The reduction in yield of the order of 10 to 20 per cent. is not accounted for by a slight depression in germination, but appears to be due more to the reduction in number of shoots per stool. The overall length of the cane does not differ appreciably between the diseased and healthy plots and, if it were not possible to make close comparisons, the depression in yield would frequently pass unnoticed. Diseased plant crops will show the effects of dry weather before healthy ones; not only does visible growth cease sooner in the diseased crops as the soil moisture becomes depleted, but symptoms of distress such as wilting during the hot hours of the day, scorching of the tips and edges of the leaves, and premature death of the older leaves, will also show earlier.

In diseased ratoon crops of susceptible varieties grown under usual farm conditions the stunting is very marked, and serious losses in tonnage result. The "usual farm conditions" are specified since regular irrigation may largely prevent the marked reduction in growth. As a matter of fact, it was this characteristic of the disease which led to the propagation of a considerable area of diseased cane when Q.28 was in process of distribution at Mackay. One of the early propagation plots was on a good farm adequately irrigated and even the ratoons there were quite satisfactory. It was not until ratoon failures in plantings on non-irrigated farms occurred that it was realized that the source of plants was contaminated. Although abundant moisture will tend to overcome the effects of the disease, the application of fertilizer does not improve the crop, nor have any par-

Fig. 37—Young ratoon field of diseased Q.28 with occasional healthy stools scattered through it.

ticular agricultural practices been observed to exercise any appreciable effect.

The ratoon crops of diseased cane do not usually show any early death of the stools, but after harvesting, particularly if conditions are dry, they come away very slowly. Within a few weeks they are well behind healthy crops of comparable age and the decrease both in number and in size of shoots in the diseased fields becomes very obvious. The diseased growing crop as well as the and become brown and tinder-dry while adjacent, healthy crops maintained the normal green top of ripening cane. It was noticed that in many apparently dead fields the sticks remained alive (without any shooting of the side buds) for some time after the leaves had died. In more favourable years there is very little death of cane, but the loss in yield is still apparent.

Heavy losses from ratoon stunting have been suffered by some farmers in practically every mill area in Queens-

Fig. 38—Healthy Q.28 ratoons on the right, diseased Q.28 ratoons on the left. Healthy cane yielded 29.16 t.p.a., diseased cane yielded 11.4 t.p.a.

fully grown cane is much more sensitive to dry weather than is the healthy. In mature cane the affected stools have fewer sticks which are much reduced in length and thickness. There is not, however, the pronounced shortening of the internodes which usually occurs when disease causes a severe stunting. Death of the stools is not a usual feature of ratoon stunting, although in 1947, when the winter and spring were dry, much of the diseased cane was dead by harvest. Prior to this many fields had lost all the green in the leaves

land and it is now clear that many of the inexplicably poor ratoon crops which often form a subject of conversation when farmers get together, are due to this disease. The authors can recall excellent plant crops of Q.28 at Mackay and in South Queensland cutting out at more than 40 tons per acre, but falling away so miserably in the ratoons that they were hardly worth harvesting. Poor ratoon yields from Trojan in the North in recent seasons are apparently also a result of the disease. Usually, however direct comparisons could not

be made with crops from disease-free material, but the circumstantial evidence seen on so many farms is backed by results from the series of trials laid down at Mackay with the variety Q.28 (*see* Table I). The comparative yields from the plant crops have already been mentioned and although the losses were considerable they were much less than in the ratoons. There the losses were up to 20 tons per acre and the diseased crops were so light that considerable extra expense was incurred in the harvesting. As an example of this the award rate for harvesting the 20.5 tons in the healthy ratoons in Trial No. 2 is approximately 14/6 per ton, but the diseased ratoons, which yielded 7.5 tons, would attract a charge of nearly 19/- per ton.

TABLE I
Summary of Yields from Five Trials
Tons of Cane per Acre

Trial No.	Planting material	Plant crop		Ratoon crop		Two crops	
		Yield	Loss	Yield	Loss	Yield	Loss
1	Healthy Q.28	28.6		27.6		56.2	
	Diseased Q.28	17.9	10.7	9.6	18.0	27.5	28.7
2	Healthy Q.28	36.0		20.5		56.5	
	Diseased Q.28	27.7	8.3	7.5	13.0	35.2	21.3
3	Healthy Q.28	30.2		17.0		47.2	
	Diseased Q.28	23.9	6.3	10.0	7.0	33.9	13.3
4	Healthy Q.28	40.1		29.6		69.7	
	Diseased Q.28	33.1	7.0	11.4	18.2	44.5	25.2
5	Healthy Q.28	37.3		30.3		67.6	
	Diseased Q.28	33.0	4.3	10.0	20.3	43.0	24.6

An examination of the root systems of diseased stools shows nothing which would be diagnostic of the disease. The general root mass is much reduced in size, which is only to be expected when the above-ground parts are so much smaller than normal, and the diseased stools are much easier to pull from the ground. The reduction is not confined to one type of root and it is noted that the fibrous, surface feeding roots are as undeveloped as the more massive buttress roots and the long rope roots, which in normal canes penetrate to great depths and so help to overcome the effects of a dry surface soil. What roots there are appear to be normal and there is no evidence that any soil inhabiting fungus or bacteria is associated with the disease.

As would be expected with a disease in which infection of diseased planting material is the chief means of spread, ratoon stunting does not occur in patches in a field. Either whole fields or sections of fields corresponding with the planting of diseased setts are affected. Frequently odd larger stools stand out from the surrounding stunted cane in a diseased field. This was quite common in Q.28 at Mackay and has been observed in some other varieties. The larger stools have apparently grown from setts which have somehow escaped infection and in many instances appear to be perfectly healthy. Irregularity in size of stools in diseased fields is also seen when the stocks of cane for planting are in process of becoming infected, possibly through the use of unsterilized knives when preparing plants. Under these circumstances all gradations from an odd stunted stool in a block of otherwise healthy cane to practically 100 per cent. diseased, may be encountered.

The early investigations into ratoon stunting were rendered more difficult

than for the usual obvious type of disease by the fact that the symptom of stunting was not apparent until the ratoons, and at one time it appeared that the only way to diagnose the disease would be by long and laborious inoculation of juice from suspect canes into Q.28 and subsequent growth into the ratoons. However, an internal symptom has recently been demonstrated and is apparently of general application. When diseased stools of Q.28 were carefully examined it was been considered healthy were in fact diseased all the time, that healthy Q.28 developed this symptom when inoculated with sap from diseased Q.28, and that separation into diseased and comparatively healthy material could be made on the basis of its presence or absence. The other diseases which show discoloured vascular bundles almost invariably cause the development of other, more obvious, confirmatory symptoms and it was realized that this comparatively easily recognizable

Fig. 39—Healthy Trojan ratoons on the left, diseased Trojan ratoons on the right on a farm in the Mulgrave area. The plants came from different sources, but otherwise treatments were identical.

found that the vascular bundles, or veins, or fibres, as they are sometimes called, within the stalks showed a reddish-yellow discolouration in the region of the node. This was also seen in a number of other canes which, as far as was known, were free from the disease. It had also been recorded for a number of other diseases and at the time did not offer much promise as a specific, diagnostic character for ratoon stunting. Much more interest was taken in it when inoculation tests showed that the varieties which had feature would be invaluable in further studies of the disease. Since then full use of this symptom has been made.

In looking for the discoloured bundles, the stalks should be split lengthwise and a paring cut made through the node with a sharp knife. A node which has been split shows a rough, irregular surface on which the tough vascular bundles, twisted and intertwined as they are, remain largely intact. The paring slices into the vessels of the bundles at varying angles according to the direction in which they run and so

the contents of a number of bundles are exposed at the same time. Those cut transversely will show as small dots and there will be all gradations from these to bundles cut along their length and so showing as reddened strands maybe $\frac{3}{16}$ inch in length. The discolouration should be looked for, say, at least $\frac{1}{8}$ inch in from the rind, and nodes in the middle and lower middle sections of the stalk usually show it best, for young tissues colour rapidly on exposure to the air. It occurs at the lower boundary of the hard, woody node: in the split stem this appears as an irregular, slightly curved line coinciding approximately with the slight constriction in the stalk just below the leaf scar. In varieties showing a small amount of wax the wax band is confined to this strip and serves as an indicator of the position of the lower part of the nodal tissue. A transverse cut through the stem at this part will show the reddened vascular bundles as minute dots, but they are not as easy to pick out in this section as they are in the lengthwise slicing. Reference to the photograph (Fig. 35) will show exactly where the reddened vascular bundles should be sought.

The number of veins affected varies from only one or two to so many that a mottled red line is formed across the sectioned node. They usually show more clearly a few seconds after slicing than immediately on exposure to the air and very frequently the nodes in diseased cane are dark cream or even a grey-cream, in marked contrast with those in healthy cane, which are the same creamy colour as the internodes.

Microscopic examination of thin sections through the reddened vascular bundles shows that in many cases the water conducting tubes, or xylem vessels as the botanist terms them, are clogged with a gummy material. Abnormalities also occur in these vessels resembling those found in one of the virus infections of the grape. Diseased stems usually contain a higher proportion of starch than healthy ones, but this does not appear to be sufficiently constant to be of much diagnostic value. There is no significant loss in percentage c.c.s. in diseased cane.

Distribution of the Disease.

At the present time ratoon stunting is known to occur in every cane-growing district in Queensland and it is suspected in at least two overseas countries. Identification of the disease in Queensland cane areas has been made both on the occurrence of discoloured vascular bundles and the poor ratoon crops from some varieties. On occasions proof positive has been provided by farmers planting cane from healthy and diseased sources within the one block and the differences observed leave no doubt as to the cause of the poor ratoons.

As mentioned above, the disease was first found at Mackay, but it was not long before it was seen in areas south of that centre. It was reported in 1950 as occurring on 101 of 166 farms growing Q.28 in the Maryborough and Bauple areas. Although it was found first in Q.28 in several of the southern districts there appears no doubt that the distribution of that variety (which was stopped in most areas when the disease showed) was not responsible for the introduction of the disease. All the available evidence points to it having been present there long before Q.28 came on the scene. At Bundaberg, for instance, as long ago as 1941 there were complaints of poor vigour in P.O.J.2878 plants from certain sources in comparison with those from elsewhere, and an experiment in that year on the Bundaberg Sugar Experiment Station to test the effect of using plants from a phosphate-rich and phosphate-poor soil was rendered abortive by what was probably ratoon stunting disease.

In practically all areas in Queensland there are records of the sudden decline of certain varieties, a general loss in vigour which could not be explained by soil deterioration or other factor. First the declines occurred in the older varieties and then as new canes came in, they in turn were affected and farmers eagerly sought another new batch. Within the last two decades

M. 1900 S., D.1135 and Q.813 have become less vigorous in various parts of the State, successors in the form of P.O.J.2878 and Co.290 were successful for a while and then faded, and at the moment C.P.29/116 in the south and Trojan in the north are threatened, and the opinion is already expressed that these varieties " are not so good as they used to be."

The distribution of the disease within individual mill areas is still a subject for investigation, but it appears that the disease and have continued to grow the variety with success.

The suspicion that ratoon stunting may be present outside Australia does not come from the reports of overseas pathologists, but depends on the discovery of discoloured vascular bundles in imported canes growing in the Bureau quarantine house in Brisbane. After growing there under observation for twelve months they were ready for distribution to the Experiment Stations when the discolourations were observed.

Fig. 40—Healthy P.O.J.2878 ratoons on the right, diseased P.O.J.2878 ratoons on the left; Mackay district.

the infection does not usually occur over all the stocks of a particular variety, or at least may vary in intensity, so that plants from one source will frequently yield better crops than those from another. This is well demonstrated in the Mackay district, where losses in Q.28 to 1949 were of the order of 100,000 tons of cane, and a survey in that year on the basis of stunting alone showed the disease to be present on 10 per cent. of the farms but many farms there have remained free from

The pathologists in the countries concerned were immediately informed, but the results of inspections in their respective countries are not yet to hand.

The Causal Agent.

" What causes it ? " is one of the first questions asked by a pathologist when confronted with a new disease, for on the answer largely depends the control measures to be adopted. In ratoon stunting there was no obvious external cause and the search was

extended to internal tissues of the plant. A great number of sections cut to microscopic thinness were made of various parts of leaves, stems and roots, but no evidence was found of any bacterial or fungal infection. The only abnormality found in the diseased plants and not in the healthy consisted of gummy masses in some of the water-conducting elements in the vascular bundles. These peculiar structures, which by their position could interfere with the free flow of sap in the

Fig. 41—Healthy stool of Trojan ratoons on the right, diseased stool on the left.

plant, are similar to those found in a virus disease of the grape and may be indicative of a virus infection. Numerous isolations were attempted from all parts of plants affected with ratoon stunting, but with negative results in all cases; no bacteria or fungi could be found.

In further attempts to identify the agent causing ratoon stunting, the electron microscope was used. This instrument gives a magnification very much greater than that of the regular microscope using light: a good research microscope will give a satisfactory magnification of over one thousand diameters, but the working magnification of a microscope using electrons is of the order of 100,000. The electron microscope is not suitable for the examination of plant tissues except in extremely small portions, so samples of diseased and healthy juices were forwarded for examination. The specialists handling the electron microscope at the laboratory of the Commonwealth Scientific and Industrial Research Organization, Melbourne, reported that there was no evidence of the presence of any abnormalities in the diseased juice. This does not of course rule out the possibility that differences between normal and diseased juice will be recorded when methods of concentrating the disease causing factor in infectious juice are developed.

Another method of identification used with some virus diseases involves inoculation of the suspect juice into animals which in positive cases will react by producing anti-bodies to the disease-causing factor in the blood serum. This works very well for some of the plant diseases, such as tobacco mosaic, in which the active principle is stable and can be purified to a high degree. It has not yet been possible to purify or concentrate the ratoon stunting causal agent, but inoculations were made into rabbits with the crude expressed sap. There was some indication that anti-bodies were obtained, but at present the test is not regarded as being sufficiently reliable for the diagnosis of the disease.

In summarizing the present knowledge of the causal agent of ratoon stunting disease, we have an ability to cause disease, an apparent inability to multiply under ordinary laboratory cultural conditions, and a very small size compared with fungi and bacteria. Although negative results were obtained with the electron microscope, there were indications of success with the rabbit test. Taking all this information into consideration the conclusion is warranted that ratoon stunting is caused by a virus. This type of disease is already familiar to Queensland cane growers in

the form of Fiji, mosaic and dwarf diseases and it is likely that chlorotic streak also belongs to this group.

Transmission of the Disease.

The term "transmission" is meant to include the transference of disease from a diseased plant to a healthy. The method by which it occurs is of importance in working out control measures against the disease. Methods of transmission vary from one disease to another and more than one method may be involved in a particular disease. Fiji disease, for instance, is known to be spread by an insect which ingests diseased juice and later inoculates it into healthy cane; it cannot be spread by mechanical inoculation using a hypodermic syringe, or by the cane knife. In contrast, the bacterial disease known as gumming, happily now apparently gone from Queensland cane-fields, can be spread easily by cutters moving from diseased to healthy plants, and can also be spread by flies getting bacteria on their legs and later alighting on a receptive surface; wind-blown rain will also carry the bacteria from one plant to another.

Ratoon stunting disease can be readily transmitted mechanically and some spread has also occurred from plant to plant in the field by some unknown method. Various inoculation tests have shown that stem juice is very infectious and will remain so even if diluted with water up to 10,000 times. It would appear that sap expressed from leaves of diseased plants is also infectious, but not to the same extent as that from the stalks.

Fig. 42—A severely stunted plot of a susceptible seedling variety in foreground, with a normally grown seedling in the background. Up to this crop yields of the two varieties were approximately equal.

Cane setts may be infected with the disease by dipping the cut ends into infective juice, by inoculating the ends with a device forcing the juice into the tissue under pressure, or simply by cutting with a knife which has recently been used on diseased stalks. The first two methods of inoculation are reliable and are used (particularly the pressure inoculation) for nearly all the experimental work, but knife infection is the important method of spread under

commercial conditions. The ordinary cane knife is quite efficient as a means of spreading infection, but the blades of the cutter-planter are even better. In one of the early trials, planted with a cutter-planter, the direction of travel of the machine from and to diseased plots could be easily seen from the occurrence of diseased stools in the ratoons of the surrounding healthy cane further along the rows in the same field. It was evident that as the machine moved along the furrow after cutting and planting setts of diseased cane, it infected the healthy setts for some considerable distance, but as the infection on the knives became diluted with the fresh healthy juice the proportion of setts becoming infected decreased until, some 40 yards from the edge of the diseased plot, all the resulting stools were healthy. On the return journey across the field along another drill there was of course no infection and the stools remained healthy right to the edge of the diseased plot (*see* Fig. 44).

The inoculation of setts is easy, and stalks of growing cane can be infected by injection of diseased juice, but attempts at inoculation of other parts of the plant have so far been unsuccessful. The method of inoculation used successfully for mosaic disease in which a pin is repeatedly pricked through a leaf from a diseased plant held tightly around the young rolled leaves, did not transmit ratoon stunting. Similar pricking through a drop of infectious juice also failed, but it may be that inoculation in this manner has to be carried out during a limited period of the year to be successful and further leaf inoculations are planned.

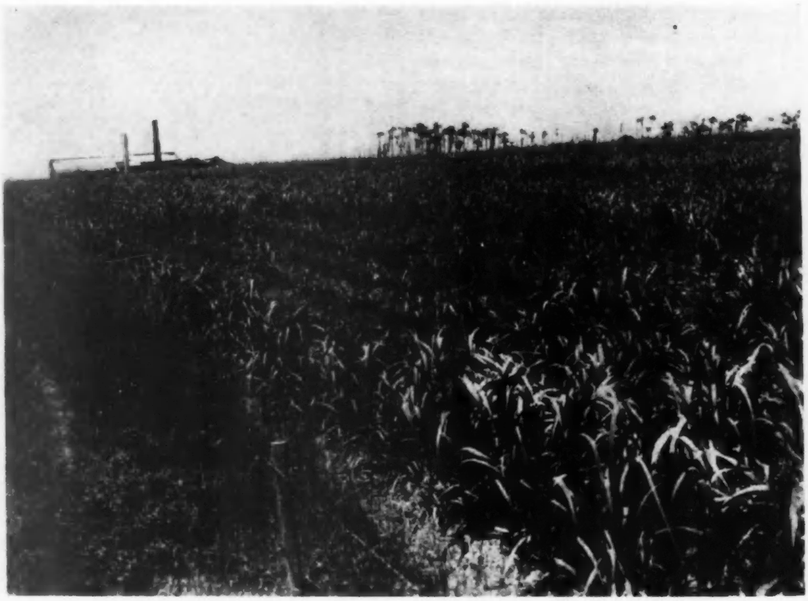


Fig. 43—Plots in a randomized block trial showing severe stunting caused by the disease.

In any cane disease, it is important to know whether there is any possibility of infection remaining latent in the ground after a diseased crop has been ploughed out. Inoculation tests into setts were therefore made using extracts

of soil, in which crops infected with ratoon stunting were growing, and also of pieces of old stubble which, after showing the disease, had been ploughed out the previous year. Results were negative, which was not unexpected in view of the known short length of time for which diseased juice remains infective. Even though the disease may not persist in the soil there is always the possibility that an odd stool of the diseased crop may volunteer with the subsequent planting, so farmers should be very careful that all stools of the ploughout are destroyed.

Primary infection, that is, infection arising from the planting of a diseased sett, appears to be the most important method of spread of ratoon stunting and certainly primarily infected stools show much more serious stunting than those which acquire the disease sometime during growth. This later infection is termed "secondary" and may be due to infection carried from stool to stool on the cane knives at harvest but, in addition, there is some evidence that an unknown method of infection does exist. In the wet end of an experimental planting in the Mackay district some spread from diseased to healthy plants was observed under conditions ruling out any spread by knife. Only guesses could be made as to the agent involved; it could have been contact from row to row either above ground or below, or an insect or some soil borne agent, or may have resulted from damage to the roots during cultivation.

Spread of the disease in the growing crop, as evidenced by stunting, does not appear to be very rapid, and numerous instances have been seen in which diseased and healthy plantings made side by side, or end to end in the same rows, have maintained the big differences seen in the first ratoons for at least two more crops. Both lots of plantings received identical treatment and no attempt was made to sterilize knives when moving from one section to another. The lack of spread may, however, often be more apparent than real because the still large stools which came from healthy material may show the characteristic, reddened vascular bundles, and setts from them produce diseased stools when planted.

Although some diseases of cane, *e.g.*, mosaic, red rot and gumming, can infect grasses other than sugar cane, there is no evidence at present that ratoon stunting exists in any alternate host plant.

Control of the Disease.

Although there are considerable gaps in our knowledge of ratoon stunting, sufficient is already known for recommendations to be made for its control in commercial cane plantings. The most important control measure consists in the use of disease-free planting material, but the prevention of mechanical transmission is of value in certain circumstances, and the use of less susceptible varieties may also help reduce losses from the disease.

Once a stool is infected with ratoon stunting, there is no recovery from the disease and all setts taken from the diseased stool will give rise to infected plants. Every precaution should therefore be taken that only disease-free setts are planted on the farm. In most districts there are farms on which ratoon stunting has never appeared and satisfactory ratoons have been grown for a number of years. Such farms should provide a source of comparatively disease-free planting material, providing the crops on them have not been irrigated, for as mentioned above, adequate watering will tend to hide the disease even in susceptible varieties. These apparently disease-free farms cannot of course be guaranteed free from the disease, for it may be that only tolerant varieties are grown on them or infection may have been so recent that it has not yet become obvious; however, steps are now being taken to keep records of disease-free sources, and within a few years it should be possible to guarantee particular farms as being free from the disease. In the meantime, selection from the non-pedigree, apparently clean sources

should yield a high percentage of healthy plants.

The practice of using plant cane for plants should be discontinued as a general rule as it is much safer to get them from well-grown ratoon canes. Districts vary in the use of plant or ratoon crops for plants but, as far as is known, there is no proved agricultural reason why there should be any preference for plant crops.

The question might be asked as to whether the large stools often seen in diseased blocks could be used as a source of plants. The answer is an emphatic "no," because usually they are diseased and plants from them give rise to diseased crops.

It is fortunate that ratoon stunting disease can be cured in the sett by heat treatment, thus yielding plants which can be guaranteed free from the disease. However, the most convenient treatment goes very close to killing the cane, and with many varieties may result in a very poor germination. The heat treatment may be given either by immersion in hot water or in a hot-air oven. It has been found that the following treatments in hot water will allow diseased setts of Q.28 to produce healthy crops:—

50° C. (122° F.) for 1½ hours.
52° C. (125.6° F.) for 1 hour and 1½ hours.
54° C. (129.2° F.) for ¾ hour, 1 hour and 1¼ hours.
55° C. (131° F.) for 1 hour.
58° C. (136.4° F.) for ½ hour.

Fig. 44—Transmission by the cutter planter. The row in the centre was infected as the planter moved away from the diseased plot in the foreground.

The germination obtained from the treatments at 55° C. and 58° C. were five per cent. or less, and it is obvious that baths at this temperature would not be practicable. Treatments for less than the stated times failed to cure the disease and, to make certain that a cure is effected, the treatment at 54° C. for one hour, or at 52° C. for one and

a half hours, is recommended at present. It is possible that 50° C. for two hours may be quite safe, and further experiments are under way to determine whether less drastic treatments than those recommended could be used. The two treatments recommended gave satisfactory germinations with the Q.28 used in the experiments, but tests with a range of varieties show that some canes are much more sensitive than Q.28. This is especially so when plants from young, succulent crops are treated. Mature crops yield much more resistant setts and should be sought as a source of plants for treatment. However, even when the plants are specially selected there are some varieties which germinate poorly after treatment.

Treatment in a hot-air oven at 50° C. (122° F.) for 24 hours, or at 54° C. (129° F.) for eight hours, will also cure the disease in Q.28. Oven treatment is not as easy as that in water for handling plants on a commercial scale and to date it has been used only for experimental purposes. Germinations after these treatments are quite reliable and they may have to be used with varieties which will not tolerate the hot water treatments.

Both types of heat treatments render the setts more susceptible to invasion by rotting organisms in the soil, since the treatments do lead to some death of cells on the cut surfaces and on the rind in the nodal region. The dead tissues provide an ideal breeding ground for soil organisms and the sett is rotted much more quickly than normal. It is essential, therefore, that the setts receive some protection from these. This can be given by immersion in a mercurial solution such as is used for the protection of plants against pineapple disease. The heat treated setts may be dipped in a solution of normal strength, *i.e.*, 1 lb. per 20 gallons of "Aretan," "Baytan," or "Mertan," after treatment or, in the case of the hot water, the bath itself may contain the mercurial. A strength of 1 lb. of the trade preparations named in 100 gallons of water is sufficient for the hot bath, but in replenishing the solution as it is used the normal strength should be added and, as a precaution, it is not advisable to keep the bath in operation for more than a working week without replacing the whole solution. The weaker strength is recommended for the hot bath only on the grounds of economy and no harm should result if the full strength is used.

The fact that guaranteed healthy plants can be obtained leads one to conclude that some district-wide, clean seed scheme should be inaugurated for all mill areas. In some districts this is already under way with plants treated in hot water being used to provide a nucleus for further plantings under strict supervision next year. The form the scheme ultimately takes will depend on whether it is decided to have a few comparatively large plantings of healthy, treated material or to have a small planting on a large number of farms; future experience will also decide whether it will be advisable to keep injecting a continuous supply of clean plants into the planting programme of the district, or whether clean stocks can be easily maintained on individual farms. Whatever the detail of the ultimate scheme, it is obvious that the treatment of the setts will have to be a matter for the close, skilled supervision of the Cane Pest and Disease Control Board supervisors.

Fig. 45—Stool of Q.28 on left was cured by hot-water treatment, stool in right foreground is diseased.

The prevention of mechanical transmission of the disease is an important item in control. As mentioned above,

ratoon stunting is readily transmissible by knives and cutter-planters and, although proof is lacking at the moment, it is thought that implements such as stubble shavers and harvesting machines could easily spread the disease from stool to stool or field to field. It would obviously be impossible to destroy all the disease causing agent on the cane knife or blade of the cutter-planter as they are being used, and the aim should be to prevent infective juice being brought into contact with a clean crop or clean planting material. The infectious agent can be easily destroyed on metal surfaces by heat. Boiling water may be poured on to the knives in the cutter-planter, or cane knives can be dipped in it. Cane knives may also be sterilized, after the caked juice and soil has been scraped off, by washing in methylated spirits; if conditions are suitable, an added assurance of sterilization is given by lighting the spirits on the blade.

Knives and cutter-planters should be sterilized before moving from one block to another and the farmer should be on the alert to check the use of unsterilized knives for such miscellaneous jobs as that "bundle of cane tops" for the horse or for the few plants, taken in the handiest spot, necessary to complete the planting of a paddock. Farmers and Pest Board officers should also watch their own actions; stalk samples taken for maturity testing or examination for disease, for instance, should always be *broken* from the stool, and not nicked out with a knife which may not have been sterilized.

The use of resistant varieties for the control of ratoon stunting disease does not at the moment offer as much hope of success as it did in the past with such diseases as gumming and downy mildew. Many of the present commercial varieties and many of the advanced Bureau seedlings are quite susceptible to the disease, and those which do not suffer severe losses from the disease are not sufficiently numerous to be of much value in district-wide control schemes. The answer may lie in the breeding of specially resistant canes, but the lack of knowledge of the inheritance of resistance, the small number of parents which might be of some use, and the necessarily very slow process of cane breeding, means that it will be many years, if ever, before successful commercial canes which are also resistant to ratoon stunting could be bred. At the present time it is known from plantings on a commercial scale that heavy losses can occur in the following canes:—M. 1900 S., P.O.J.2878, Q.28, Q.42, Q.45, Q.813, and Trojan. Varieties which have produced reasonable crops even when infected include Badila, C.P.29/116, Pindar, Q.47, and Q.50. It should be noted that susceptibility to ratoon stunting disease infers a liability to suffer losses, but as far as is known this does not mean that susceptible varieties are more likely to get the disease than others. Precautions to prevent infection will therefore be quite as effective for Q.28 as for the more resistant, or less damaged, Q.50. It also means a variety need not be lost to a district immediately it is shown to suffer losses from the disease; in Mackay, for example, many farmers are still successfully growing Q.28, and will no doubt continue to do so until some cane more suitable for their conditions comes along.

The masking of the disease, *i.e.*, its occurrence without any obvious symptom, has also to be considered in any control scheme. A variety such as Q.50 may show very little stunting except in particular circumstances, and it may be difficult to find the discoloured bundles, but the juice of stalks from the suspected block will give positive results when inoculated into Q.28, and the subsequent crop of Q.28 examined. Unless knives are sterilized after cutting such an apparently healthy block the disease would be spread into other blocks. There is evidence that a large number of varieties may mask the stunting in the ratoons and, of course, stunting in the plant crop is usually so inconspicuous as to need specially designed trials to discover. Even the susceptible Q.28 may not show stunting in the ratoons if conditions for growth

are very favourable, and the more resistant varieties, such as Q.50, may show damage only on rare occasions in commercial plantings.

Summing up the methods of control, it is apparent that clean seed is the first requisite, that cane knives and the blades of the cutter-planter can be of importance in spreading infection, that resistant varieties do not at the moment offer much promise and that diseased but apparently free crops can be a threat. Hope of success in the control of the disease comes from the fact that clean seed can be obtained and that natural spread from field to field, or even within a field, is comparatively slow.

Poor Patches in Cane Fields

A considerable number of soil samples forwarded by cane growers for analysis are taken from "poor" patches in fields. The growers notice that, despite their normal fertilizer practice, such patches lag behind the remainder of the field and produce much smaller crops. They generally assume that lack of plant foods is the reason for the crop failure. It is only rarely that this explanation is the correct one.

In general the soil analysis shows that the plant food content of the poor patch is the same as in the remainder of the field; in some cases it is better, because of the smaller amounts being removed by the lighter crop. Consequently soil analysis fails, in most cases, to supply the answer to the problem. The next step is to examine the soil in the field to find out whether some factor other than plant food supply will provide the solution. It is usually discovered that one or more of the following conditions exists:—

(1) A depression which is poorly drained and in which water will lie and waterlog the soil for considerable periods after rain.

(2) In a quite uniform field and with no apparent difference in surface soil a poor patch will be found to be underlain by a stony sub-surface layer, by ironstone gravel, or by a body of sand.

(3) A sandy-loam surface soil, which does not alter to plough depth, sometimes changes to a coarse sandy or gravelly sub-soil.

(4) Occasionally "hardpans" are found at or just below plough depth on forest soils. These may be formed of ironstone deposits cemented into an impermeable layer, causing a barrier to root penetration.

In the first example above the poor patch would be caused by inadequate drainage and the only solution would be to make provision for leading off the surplus water. In the second and third cases the cause would be lack of moisture at critical periods because of the poor water holding capacity of the sand or gravel. Such cases occur in many Queensland cane growing areas. In the fourth example the hardpan would have to be broken by deep subsoiling. This has produced excellent results in parts of the Mackay district.

Poor patches can also be caused by salt areas which occur in some districts where saline springs flow from hillsides, but these are infrequent.

Growers are accordingly advised to investigate the reason for growth failures in small areas by digging down into the subsoil. If the reason is not apparent and the soil analysis does not indicate a plant food deficiency an approach to the local Sugar Bureau officer should be made.

N.J.K.

Expansion of the Sugar Industry in Queensland*

By NORMAN J. KING

The phrase " expansion of the sugar industry " has become so commonplace during the past year or two that one is apt to overlook the reasons behind the rapid development and the effort and expenditure which will be required to reach the proclaimed target. So as to obtain some perspective in the matter, it becomes necessary to look back some twenty-eight years to when Australia, for the first time, became independent of imported sugar. During that relatively small span of years Australia's population has increased from less than six millions to between eight and a half and nine millions; it has become the world's heaviest consumer of sugar per head; and at the same time the sugar output has increased so greatly that the exportable surplus reached a figure of 515,000 tons in 1939, although it has not since attained that magnitude.

This would have been no mean achievement in a country which was already well developed, and which possessed amenities and living conditions similar to those enjoyed in our cities; but this progress was made largely in the northern divisions of the State, in an environment which has no parallel in other Australian agricultural pursuits. It should never be overlooked that Queensland's sugar industry is a social experiment which is unique in world history. No other tropical undertaking of such magnitude is carried on entirely by European labour.

The growth from 1924 to date was gradual rather than spectacular. During the period only one new district was opened for settlement, that at Tully, but all other areas from Nambour in the south to Mossman in the north increased both their cultivated areas and their standards of agricultural efficiency, until in 1950 a peak of production was reached with a harvested crop of 6,700,000 tons of cane.

The advent of war was rapidly followed by a recession in output caused by the diversion of field labour to other occupations, the enlistment of farmers and their sons, the impressment of tractors and the severe rationing of fertilizers. Not until 1948 did the industry return to its pre-war level, and simultaneous with that recovery came the first move for expansion of production. This was the Returned Soldiers' Land Settlement Scheme, under which returned men were settled on new sugar land to the extent of increasing peak production by three per cent.

But the major expansion, the development in which the industry is involved at the present time, springs from a different source. Britain, although a sugar producer herself to the extent of some three-quarters of a million tons of beet sugar annually, is also a large importer, and as such offers a preferential market to Australia. Under a recently negotiated Empire agreement Australia has an export quota of 600,000 tons of sugar from 1953 onwards, and since present Australian consumption approximates 550,000 tons, which will become greater as population increases, a speedy and appreciable stepping up of production is essential. A recital of figures in a talk such as this may tend to be confusing, but some idea of the expansion envisaged is obtainable from the recent pronouncement on the subject by the Minister for Agriculture and Stock. Mr. Collins' statement disclosed that the gross acreage assigned for sugar cane growing in 1948 has been increased by 37 per cent. to give a total cultivable area of just under 600,000 acres.

This is a phenomenal increase for attainment within a short period and it raises many problems not only in the spheres of land preparation and agriculture, but also in factory capacity,

* An ABC Broadcast Address

transport of cane and sugar, labour requirement, implement and fertilizer supply, specialized milling equipment and finance. Much of the farm development will be on existing farms, over 4,000 of which have had their assigned acreages increased, but nearly 1,100 new assignments have been granted, and this will build up the total number of cane growers to nearly 8,200. On the manufacturing side the heavy increase in sugar output will continue, for some years at least, to be handled by the existing thirty-one factories. Practically all units are at the present time installing new and costly plant, and have planned further extensions in the approaching year. Sugar mill equipment is very costly, and many mills are expending in excess of half a million pounds each to achieve the desired capacity. The expenditure does not stop at the farm or the mill. Cane transport systems are affected, sugar storage has to be increased, more railway waggons and shipping will be required, and refinery capacity must keep ahead of Australian demands.

Certain critics of the sugar industry are inclined to question the necessity for expanding production when Australian requirements are already being met. They tend to overlook the pertinent fact that the British Commonwealth is a net importer of this commodity to the extent, in 1951, of half a million tons. As a member of the British Commonwealth, Australia can, by expanding her industry, reduce this deficiency and at the same time improve the overall trade balance. Since 1924, when sugar was first exported, the value of those exports has totalled £112,000,000. In the same period the existence of an Australian Sugar industry has saved the home consumers £63,000,000, which is the difference between Australian prices and the lowest foreign sugar prices at which purchases could have been made.

Another cogent reason for expansion is that no other form of agricultural production could economically be pursued to a material extent on the lands now devoted to sugar growing.

The sugar industry developed the Queensland tropics, is mainly responsible for the railways, harbours, roads and towns along the coast, and supports some 200,000 people, directly and indirectly, in sugar districts. An undertaking of the magnitude of the sugar industry contributes to the economy of many people beyond its borders. It requires machinery, tractors, farm implements, oil, fuel, locomotives, ships, cars, trucks, food and all the necessities of life. These and many others have to be purchased from other States and countries. Expansion will naturally increase these requirements, and other industries and other States will automatically reap a benefit resulting from amplified trade.

At the present time the complete duplication of one factory is proceeding, thereby almost doubling its capacity. As Australian sugar requirements grow with population increase, others will no doubt follow suit, and there is, in addition, land available in some areas for new mills. The present expansion plans do not exhaust Queensland's potentialities for sugar production, but the investigations carried out in recent years do indicate that the area of suitable land is by no means unlimited. As against this the high and constantly improving efficiency of sugar production in this State will ensure that the best use is made of every acre, and that the capacity of our soils to produce will be fully exploited.

It would appear unlikely, in the foreseeable future at least, that sugar cane growing will develop north of Mossman. The Daintree lands are not sufficiently extensive for large scale development and the rainfall in the Cooktown area is rather too uncertain in its distribution. Between these two centres is the Bloomfield River, but little information is available regarding the extend of land or reliability of rainfall.

A sugar mill was built on the Bloomfield River in the last century, but it was not a success. The principal obstacles to the industry developing northwards beyond its present borders

would be transport and isolation. There are no railways; road transport of sugar as far south as Cairns would be too costly; deep water harbours would have to be developed, and the labour position would be too uncertain.

Expansion of the industry within or near to its existing boundaries is the more reasonable proposal. Although the strain on railways, roads and harbours will be greater there will be no need for large capital expenditure on new lines or new installations. In the main, existing towns will tender to the trade needs of new farmers, although in the case of the Abergowrie district where a major farming area is being developed a new town site is planned.

The value of the expansion to Queensland is difficult of assessment. This year's sugar output, estimated at 906,000 tons, will attract an average overall price approximating £43/10/- per ton, or about £39,500,000 in the aggregate. When the planned Queensland peak is attained it would mean, using the same sugar values, an extra income of £11 millions. In addition there would be the added capital value of the new farms, buildings, and machinery as well as the improvements in mills and auxiliary equipment.

The value of the extra sugar as I have calculated it may be considered to be over optimistic. Only half of the export quota will be sold under the guaranteed price negotiated from year to year, and the remainder would be sold at world price plus preference. Either figure is subject to reduction should a downward trend develop in the world's sugar market. But the calculation does indicate the proportionate increase in industry income which could be expected to accrue from the augmented output.

There is another important aspect of this transformation process. The sugar industry possesses its own agricultural and milling research organization. At the moment it is barely sufficient to perform the investigational and extension services to maintain the desired high degree of efficiency and progress. With a further 1,100 growers and an increase of 37 per cent. in the total area the demands on research and extension will multiply accordingly. Similar enlargement of services will be necessary in the field of mill research. The increases in mill capacity which are being brought about largely by bigger crushing plants, higher rates, and the incorporation of new and improved equipment, will bring in their train specialized problems in engineering and manufacture. Since increased efficiency will also be sought the extension of research activities must be linked with higher standards of investigation.

The magnitude of the expansion scheme is appreciated only if viewed in State-wide perspective. The various organizations closely associated with the industry obviously have a considerable measure of faith in its future to plan and foster such a large scale development, and the Government signatories to the Empire agreement both in Australia and Great Britain have demonstrated their confidence in our ability to achieve the set target.

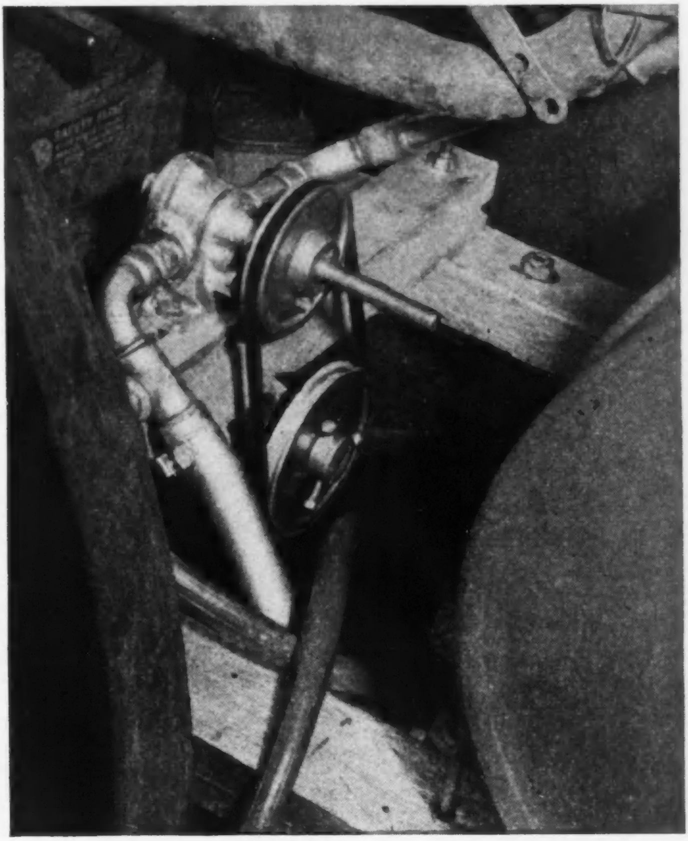
Food is the outstanding shortage in the world to-day, and it is in the underdeveloped countries such as Australia that production can be stepped up most rapidly. Queensland's future is clearly linked to its agricultural development and to date sugar has led the way in settlement, production value and efficiency. Cane growers' sons, field workers and cane cutters are anxious to become cane farmers in their own right, and there is no dearth of applicants from outside the industry who desire to obtain cane growing assignments. This reversal of the much criticised drift to the cities is indicative of a desire to make farming their livelihood, and augurs well for the future of Queensland.

Farm Built Equipment

A GUIDE TO BUILDING A SUITABLE POWER SPRAY

By L. G. VALLANCE

Because of the capital cost of commercial units, by far the greater number of power sprays in use in the various sugar districts have been made by the growers themselves. The fundamental principles are simple, and with power available either from the power take off (Fig. 46) or the fan spindle (Fig. 47) of the tractor, many neat and efficient units have been constructed. With the exception of some pipe threading by the local plumber, and possibly some welding, little outside assistance has been found to be necessary.



Photo, Stacks Studio, Innisfail

Fig. 46—Showing pump driven from the tractor power take-off.

The actual details vary somewhat according to the material available and the type of tractor in use, but the basic design is as shown in Fig. 48.

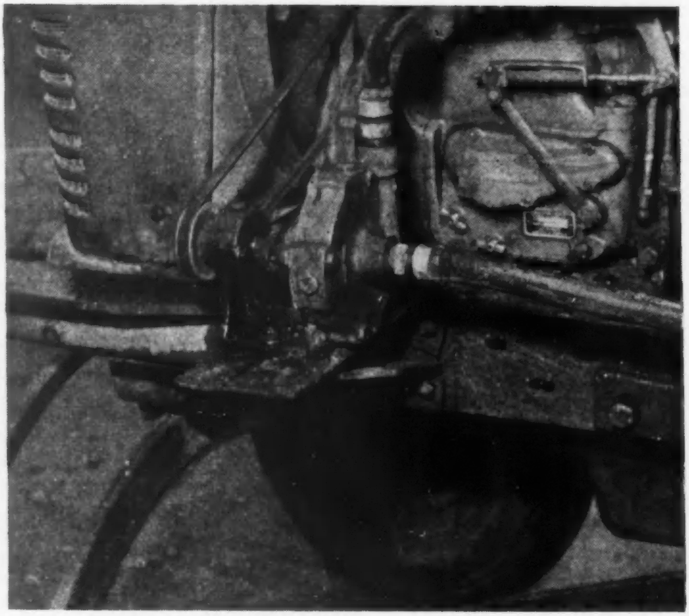
The diagram of this single layout is self explanatory. For spraying through

the boom, cocks A and C are open and cock B is closed. Cock D in the by-pass line is partly open, and adjusted so that while the nozzles are working at sufficient pressure and delivering the required spray, the excess liquid is returned to the container. The correct adjustment is obtained when the output of the equipment is being measured under working conditions. The output may be estimated simply by measuring how much liquid is discharged per run of given length of field or in a certain period of time.

If required the pump may be used for filling the container. In this case, cocks A and C will be closed while B and D are fully open. It is a good idea to wrap a piece of gauze around the end of the flexible hose which leads from cock B to the water supply. The outfit may also be used as a hand spraying outfit by attaching a hand piece and nozzle to the hose attached to cock D. For this use, cocks B and C will be closed. It will be noticed that high pressure taps have been shown in the diagram for A, B, C, and D. These are usually more suitable than the low pressure or ordinary tank tap.

Before purchasing the various components to make the equipment it is first of all necessary to decide upon the capacity of the outfit that will be required. For instance, it is no use buying a pump of 100 gallons per hour capacity when by operating the tractor at a convenient speed an outfit delivering 200 gallons per hour will be needed. Then again, the output per hour will depend upon the number of rows to be sprayed per run.

On level country with good conditions, it will be possible to spray six rows at a time. Where the ground surface is uneven, a three to four row boom is the maximum that can be handled efficiently. Some farmers are



—Photo, Stacks Studio, Innisfail

Fig. 47—Pump driven from fan spindle of tractor.

operating single row sprays, but such small outfits are hardly worth while, except in special cases.

Table 1 has been prepared to show the amount of liquid in gallons per hour passing through the spray when spraying at the rate of 20, 30 or 40 gallons per acre, covering 1, 2, 3, 4, 5, or 6 rows at a time at a tractor speed of 2, 3 or 4 miles per hour. For instance, for a tractor with a convenient working speed of 3 m.p.h. and with a boom treating six rows at the one time with spray at the rate of 20 gallons per acre, the outfit will require to be able to deliver at least 196 gallons per hour. Therefore, the pump and nozzles should be selected so that this amount will be within their capacity with a margin to spare.

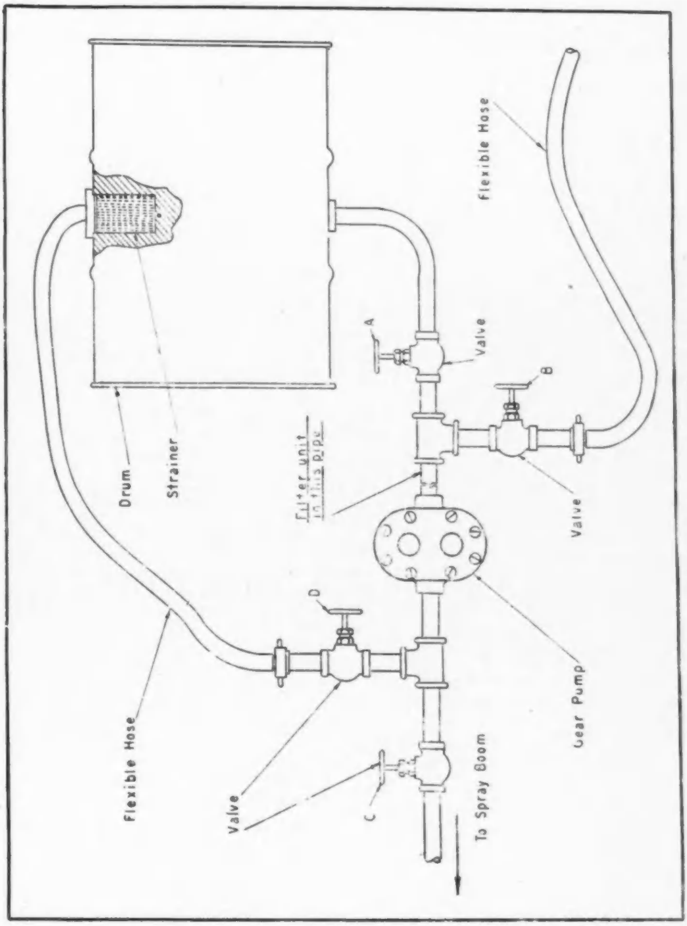


Fig. 48—A basic design for a farm built boom spray.

PUMPS

The pumps in general use for boom spray work are usually of the internal rotating type in which the rotating member or members are two gears, two eccentrics or a rotor with flexible rubber rollers. The first two types are sold by various makers and described as *gear*

pumps when gears are used, or *rotary* pumps when the water is impelled by eccentrics. The third type is the Paul roller pump and, as far as is known, is available at present in the ½ inch size only. Gear and rotary pumps are made in several sizes and are usually fitted to boom sprays in ½, ¾ or 1 inch sizes, according to the capacity required.

There is little difficulty in selecting a pump of sufficent capacity. The output in gallons peir hour is stated by the maker of the pump according to the speed at which it is driven and also the pressure at which it is operated. However, at the low pressures at which the boom spray will work, this pressure factor can be more or less disregarded when considering pump delivery.

Actually, it is usually less than 40 lbs. per square inch, and variations in the pump output over the range 10-40 lbs., particularly at the low speeds used, are negligible.

Therefore, having decided from Table 1 the gallons per hour required, the next thing to find out is the revolutions per minute at which the pump will operate. This will depend upon the r.p.m. of the power take off or the fan spindle of the tractor. This varies with the make of tractor and the engine speed, but the information, if not already known, is usually readily available from the agents or from the instruction book. The power take off of the Farmall "M," for instance, operates at 500-537 r.p.m. at normal engine operating speeds. A grower, using this type of tractor and wishing to build a spray outfit capable of delivering, say, 200 gallons per hour, would therefore need to purchase a pump which would deliver at least this amount when operated by a 500-537 r.p.m. driving pulley. Of course, as is usually done, the operating speed of the pump can be increased by fitting a larger driving pulley on the power take off than the driven pulley on the pump spindle.

As an approximate guide to the output of suitable pumps, the makers

TABLE I

Showing the required capacity of a spray outfit at different rates of application of weedicide spray per acre, with varying boom lengths and tractor speeds.

Tractor Speed	Number of Rows per run	Output of Spray (gals. per hour) when applying		
		20 gals. per acre	30 gals. per acre	40 gals. per acre
Two miles per hour	1	22	33	44
	2	44	66	88
	3	66	98	131
	4	87	131	174
	5	109	163	218
	6	131	196	262
Three miles per hour	1	33	49	66
	2	66	98	131
	3	98	148	196
	4	131	196	262
	5	163	245	327
	6	196	294	392
Four miles per hour	1	44	66	88
	2	88	132	174
	3	131	196	262
	4	174	262	348
	5	218	326	436
	6	262	392	524

Note.—These figures apply to blanket spraying. When spraying the cane row only, the output required will be approximately half that given in the table.

specifications of two well known series of pumps—the Ajax ½, ¾, and 1 inch gear pumps, and the ½ inch Paul roller pump—are given in Tables 2 and 3.

TABLE 2

"Ajax" Gear Pump (Type G)

Size	Max. speed r.p.m.	Capacity gals. per hour
½in.	500	160
¾in.	500	200
1in.	500	400

When making the plate or bracket for mounting the pump, it is a good idea to provide slotted holes so that the pump may be moved slightly to tighten or slacken the belt if required.

BY-PASS

Gear and rotary pumps are of the positive displacement type, *i.e.*, they will build up pressure if the flow of water is unduly restricted or shut off in its discharge. Some of these pumps have an inbuilt relief valve which by-passes a certain amount of the water back into the suction side of the pump when a pre-determined pressure is reached. However, such a rather expensive item is not necessary for the type of boom spray in mind. A convenient method of relieving the pressure is to have a tee-piece on the discharge side of the pump leading to a pipe-line or flexible hose return to the container. (See Fig. 48). A tap in the return pipe will then be required. The tap can be so adjusted that the required amount of liquid is passing to the nozzles whilst the excess returns to the container. If the pump has been selected to give ample delivery, the returning of a proportion of the water will not reduce the nozzle output below the necessary amount.

TABLE 3

Paul Roller Pump (½in. model No. 50)

Pressure lb. per sq. in.	700 r.p.m.	900 r.p.m.	1200 r.p.m.	1400 r.p.m.	1725 r.p.m.	2500 r.p.m.
0	100	133	177	210	258	350
8.6	96	129	168	201	252	345
12.9	94	125	163	195	250	340
21.6	94	124	162	194	245	339
34.6	94	124	162	193	240	338
43.3	92	123	162	193	234	337

A point to remember is to obtain a pump of ample capacity, particularly when it is to be also used for filling the spray liquid container when a fresh batch of spray is to be made up. The above tables are given for general guidance only and the purchaser should always obtain the specifications and r.p.m. requirements of the particular pump he is buying.

An alternative method of driving the pump is from the spare pulley which some tractors have fitted on the fan spindle. A point to be borne in mind in such a case is that when a rubber roller pump is being used, care should be taken to avoid running the pump when no liquid is passing through. This must, of course, also be avoided when the pump is being driven from the p.t.o. However, in this latter case, the pump is not working when the take off is out of gear, whereas, when being driven from the fan spindle it is in operation all the time the engine is running, unless the belt is disconnected or some other precaution taken.

With the Paul roller pump a by-pass is not necessary, since the flexibility of the rubber rollers is sufficient to give the relief required.

The returning of liquid to the tank through the by-pass is of some advantage in that it helps to agitate the spray solution in the tank and

improves the mixing. For readily soluble weedicides such as 2,4-D this agitation is not particularly necessary, and in any case the movement of the tractor ensures constant motion of the liquid in the tank. Contact spray liquids of the creosote and diesel oil type depend upon their remaining in an emulsified form in order to obtain an efficient coverage and wetting of the leaf surface. With such liquids, agitation, additional to that imparted by the movement of the tractor, is helpful.

PULLEYS

Pulleys to take a Vee belt are suitable (*see* Figs. **46**, **47**) and the main question to decide when considering pulleys is the ratio of the diameter of driving pulley to that of the driven. This will depend upon the r.p.m. of the power take off and the r.p.m. at which it is necessary to operate the pump to obtain the desired output. Actually, the ratio of the diameter of the driver to the diameter of the driven will be the same as the ratio of the r.p.m. of the driven to the r.p.m. of the driver, *i.e.*

$$\frac{\text{diameter of driver}}{\text{diameter of driven}} = \frac{\text{r.p.m. of driven}}{\text{r.p.m. of driver}}$$

For instance, if the r.p.m. of the driver on the power take off is 500 and the pump has to be driven at 1000 r.p.m. to give sufficient delivery, the required ratio is 1000 to 500 or, more simply, 2 to 1. Therefore in this case a 6 inch pulley on the power take off will require a 3 inch pulley on the pump. The formula given below should also be useful in calculating the size of the pump pulley when the pump speed and the diameter and speed of the power take off pulley are known.

NOZZLES

As would be expected, the selection of the correct nozzle is most important. Probably the first consideration is the amount of liquid that each individual nozzle will deliver. This depends upon its construction, but two factors which are of particular importance are (1) the size of the hole or orifice through which the liquid emerges, and (2) the pressure at which it is forced out.

Then, again, nozzles may be divided into two classes, both of which will give satisfactory results with the boom spray. The Greenhouse type (*see* Fig. 50) nozzle will deliver the spray in the form of a flat fan, whereas the cone type (*see* Fig. 49) delivers a hollow cone shaped spray.

Both of these types are in use with equally good results. On stony or lumpy soils the cone shaped spray may be preferable in that the leading edge of the spray will wet the soil surface under the stone as the nozzle moves towards it and the trailing edge wets beneath the stone as it moves away. The fan-shaped spray, which is fanning out at right angles to the line of motion and usually slanting backwards, does not have the same tendency to penetrate under the rear edge of the stone. However, undoubtedly fan-shaped sprays have given excellent results in the many outfits which are using them. It is claimed that these nozzles deliver the liquid with a greater force than the cone sprays and this possibly offsets the two way direction of the latter.

In actual fact, the Greenhouse nozzle is of simple construction and has the advantage of being readily procured. It is very suitable for boom spray work and gives good wide coverage with uniform application.

$$\text{diameter of pump pulley} = \frac{\text{diameter of driver} \times \text{r.p.m. of driver}}{\text{required r.p.m. of pump}}$$

Example:

diameter of driver = 5 inches
r.p.m. of driver = 640
required r.p.m. of pump = 800

Then the diameter of pump pulley $= \frac{5 \times 640}{800}$
= 4 inches.

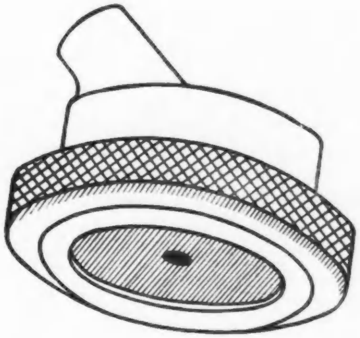


Fig. 49—A cone type of nozzle which delivers the spray as a hollow cone.

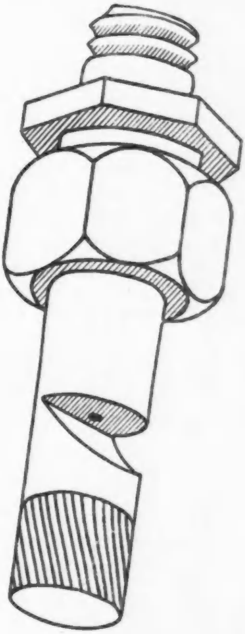


Fig. 50—Greenhouse type of nozzle. This delivers the spray in the shape of a flat fan.

Nozzle Size.

With other factors, such as pressure, etc., remaining constant, the output per hour of any nozzle will depend upon the size of its orifice. It is necessary to know the output per nozzle, since this will indicate the size required. For instance, if it is intended to spray five row widths at a time at the rate of 20 gallons per acre with the tractor working at a speed of three miles per hour, then the equipment will have to deliver about 163 gallons per hour (*see* Table 1). For this length of boom (21 feet) approximately 16 nozzles will be required to give satisfactory coverage. Therefore, each nozzle will have to be capable of delivering one-sixteenth of

TABLE 4

Delivery in gallons per hour of Greenhouse type nozzles which deliver a FAN shaped spray.

Pressure	Dia. of orifice	Gals. per hour
30 lb. per sq. in.	1/32 in.	10
	3/64 in.	21
	1/16 in.	31
	5/64 in.	52
40 lb. per sq. in.	1/32 in.	12
	3/64 in.	24
	1/16 in.	36
	5/64 in.	60

TABLE 5

Delivery in gallons per hour of Nozzles which deliver a CONE shaped spray.

Pressure	Dia. of orifice	Gals. per hour
30 lb. per sq. in.	3/64 in.	11.2
	1/16 in.	15.5
	5/64 in.	18.9
35 lb. per sq. in.	3/64 in.	12.2
	1/16 in.	16.6
	5/64 in.	19.9

163 gallons per hour, *i.e.*, just over 10 gallons per hour. As a rough guide, the approximate deliveries in gallons per hour for suitably sized nozzles at the pressures normally used are given in Tables 4 and 5.

It will be seen, therefore, from Table 4 that 16 fan nozzles of 1/32 in. diameter orifice would deliver 16 × 10 =160 gallons per hour at the working pressure of 30 lbs. If cone delivery nozzles (Table 5) were used it would be necessary to use a slightly larger diameter, *i.e.*, 3/64 in., and in this case at 30 lbs. pressure the output would be 16 × 11.2 = 179.2 gallons per hour.

In both cases, the output would be a little different from that actually required but would be within practical limits. In any case, it is practically impossible to build a machine by calculation alone to work within very

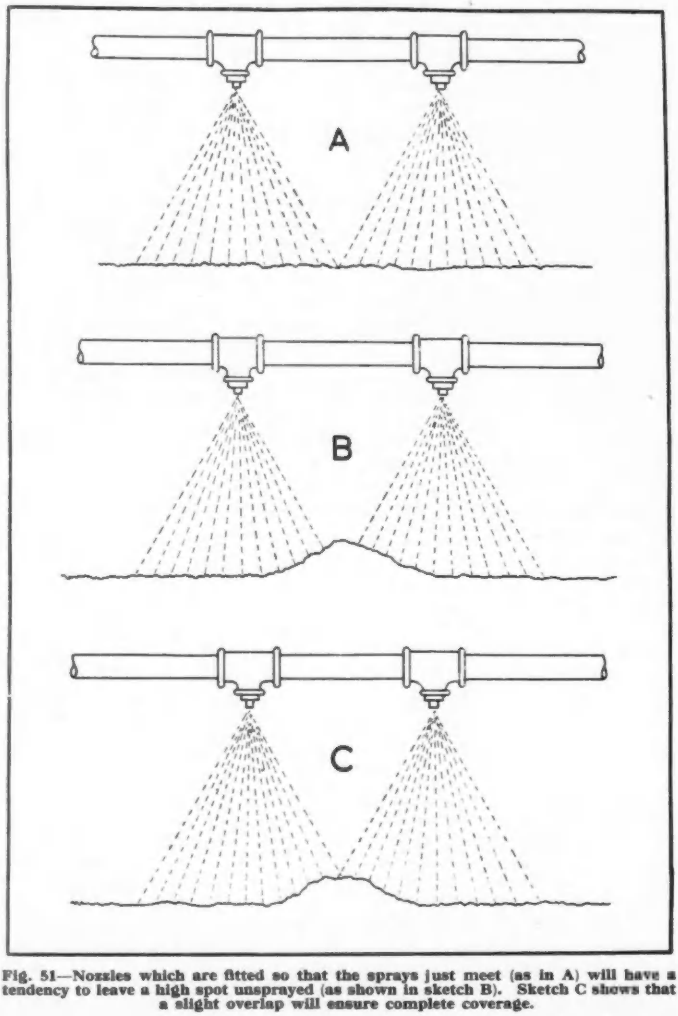


Fig. 51—Nozzles which are fitted so that the sprays just meet (as in A) will have a tendency to leave a high spot unsprayed (as shown in sketch B). Sketch C shows that a slight overlap will ensure complete coverage.

close limits. Because there are so many variables it will always be necessary to ascertain the actual output under working conditions. This is simple enough and any minor adjustments are readily made by running the tractor slightly slower or faster. Also, if necessary, it can be done by dissolving the 2,4-D in a different amount of water, say, 25 gallons instead of 20.

It must be stressed that Tables 4 and 5 are not intended to apply to all available makes of nozzle and are given only to suggest some idea of the required sizes. When purchasing nozzles their delivery rate should be ascertained if at all possible.

Number of Nozzles and Spacings on Boom.

The number of nozzles required and the distance that they should be set apart on the boom will depend on the length of the boom, which in turn depends on the number of rows to be sprayed per run. It will also depend upon the height of the nozzles above the sprayed surface, since this will control the width of the fan or cone where it strikes the ground. Then, again, variations will be necessary according to whether it is desired to give complete ground coverage, *i.e.*, blanket spraying, or whether the cane rows only are to be treated.

Provision should always be made for some means of raising or lowering the boom height above the ground, since by this means the spread of the spray where it meets the ground can be adjusted. When making final adjustments the spray from each nozzle should be allowed to overlap. Theoretically it should only be necessary that the portion sprayed by any nozzle should touch that sprayed by its neighbouring nozzle. If the soil surface were absolutely even and level this would be satisfactory. In practice, however, ridges and mounds occur in the field and as shown in Fig. 51 raised portions would not receive any spray unless the areas served by each nozzle overlapped to a certain extent. Admittedly, overlapping causes the soil to receive a double application of spray on the overlapped portion. However, this is preferable to the considerable amount

—Photo, Stacks Studio, Innisfail

Fig. 52—Showing flexible hose connection to nozzles for row spraying. This allows easy adjustment to suit different spacings. Note that the wooden boom support is jointed behind each wheel for lifting while travelling or turning. The nozzles are the greenhouse type mounted in pairs to throw both backward and forward.

of unsprayed area which would otherwise be left and in which weeds and grasses would germinate.

A point of some difficulty that may arise when considering nozzle spacings is the fact that cane rows may not always be evenly spaced. For blanket spraying this does not matter a great deal since the objective is to apply a uniform coverage over the whole area. It is of more consequence when only the cane row is to be sprayed and the middles are to be subsequently cultivated. However, many growers have overcome this difficulty for row spraying by having the nozzles fixed to rubber or plastic hose rather than galvanised piping. By this means the boom (usually 3 × 2 hardwood) is merely a support and the nozzles can be clamped in the particular position that is required (*see* Fig. 52). Such a method has definite merits for three to four row sprays and might well be adopted in many cases for preliminary work. After a season's experience the grower will have gained knowledge of the spacing requirements on his own particular farm and can then, if necessary, make the more permanent type of boom with galvanised piping.

Nozzle Spacing for Blanket Spraying.

Fig. 53 shows a medium size boom and nozzle spacing suitable for blanket spraying in cane, the rows of which are planted 4 feet 6 inches apart. The total length of this boom is 12 feet, extending 6 feet on either side of the middle of the tractor. It will spray two full interspaces and two half interspaces per run. Nine nozzles will be used, spaced evenly 18 inches apart. It will be noted that the centre nozzle is directly over the row of cane which is being straddled by the tractor. This necessitates that the break in the boom line, which is necessary for the pivoting of each section, will be slightly offset from the middle line of the tractor.

A boom of this type can be extended if desired to give a wider coverage at each run. On level country, up to six full interspaces plus two half interspaces can be covered quite satisfactorily with a considerable saving in running time and operating costs. The extensions can be carried out simply by using suitable lengths of piping and tee pieces to place additional nozzles at 18 inch spacings. It should be noticed that the last nozzle should always spray the half interspace on the outside of the outside row, *i.e.*, the row furthest from the tractor on each side (as shown in Fig. 53). If the end nozzle covers any other position, it will be found that with subsequent runs of the tractor an area equivalent to one nozzle spacing will either be missed or sprayed twice.

The 18 inch spacing refers only to use in cane the rows of which are planted 4 feet 6 inches apart. For wider planting it will, of course, be necessary to increase the spacing accordingly and the distances for different planting width are shown in Table 6. This table also shows the total boom lengths that will be required for varying coverages with different row widths. These lengths refer to the minimum overall length between the two outside nozzles on either side of the tractor. The calculation of actual piping length, of course, must take into consideration the number and size of tee pieces, threaded ends, and also the join and pivoting assembly where the two sections of the boom meet to connect with the pump delivery line.

These spacing are so calculated that the areas wetted by each nozzle will overlap slightly. This, as previously mentioned, is necessary to ensure that complete coverage is obtained, particularly on uneven surfaces. The nozzles are also arranged so that the overlapping area will not occur on the actual cane row itself. Since the overlap actually receives a double dose of chemical, it is preferable to avoid its falling on the line of cane setts or young stools. With nozzles whose fan or cone angle is about 60 degrees as it leaves the nozzle orifice, the overlap will be about two inches at each side when the height of the nozzle is 18 inches above ground level. This can be increased or decreased by adjusting the

height above the surface. In most cases it is preferable to work with the nozzles reasonably low, since this will minimise wind effect, and in young cane the spray will get under leaves which might otherwise prevent a certain proportion from reaching the soil.

Fig. 54 may be useful in that it indicates the width of the wetted area at different nozzle heights above ground. It should be noted that it applies only for fan or cone angles of 60 degrees. For practical purposes, this may be regarded as the usual angle, but it does vary according to the type of nozzle and the pressure. Unfortunately when purchasing a nozzle it is seldom possible to obtain information regarding its particular angle of delivery. Nevertheless, the figures quoted will be found to be helpful particularly when making provision for the raising and lowering of the boom. In practice any adjustment of overlap is readily made by altering

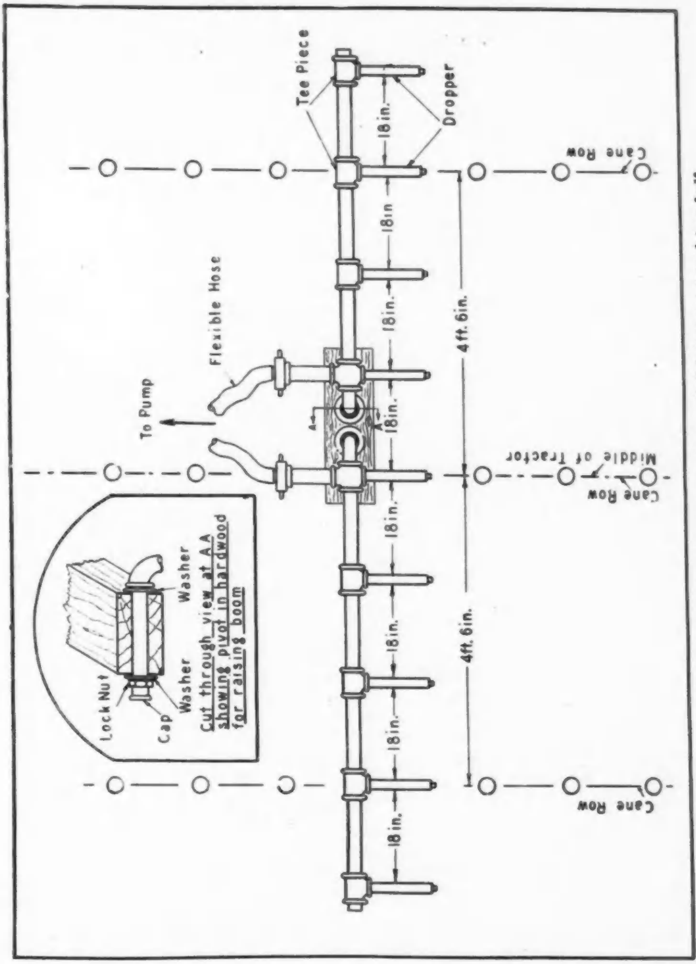


Fig. 53—Showing the layout of a boom to cover two full interspaces and two half interspaces. INSET—Detail of pivoting assembly.

TABLE 6

For Blanket Spraying

Showing total length of boom and the number of nozzles required for different coverages and row widths.

Coverage	Number of nozzles	Width apart of rows			
		4ft. 6in.	4ft. 8in.	4ft. 10in.	5ft. 0in.
		Total length of boom			
		ft. in.	ft. in.	ft. in.	ft. in.
6 full interspaces plus 2 half interspaces	21	30 0	31 1½	32 3	33 4
4 full interspaces plus 2 half interspaces	15	21 0	21 9½	22 7	23 4
2 full interspaces plus 2 half interspaces	9	12 0	12 5½	12 11	13 4
Nozzle spacing (inches apart)		18	18⅔	19⅓	20

the boom height as required. It may be noted that since the Greenhouse or flat fan spray nozzle directs its delivery slightly backward, it has a somewhat greater coverage at a fixed height than a cone spray nozzle which directs its delivery immediately downwards.

Nozzle Spacing for Row Spraying.

A suitable method is to place each nozzle directly over the row to be sprayed. As previously mentioned, plastic or rubber hose to the nozzle allows it to be clamped in any position desired (*see* Fig. 52). This will take

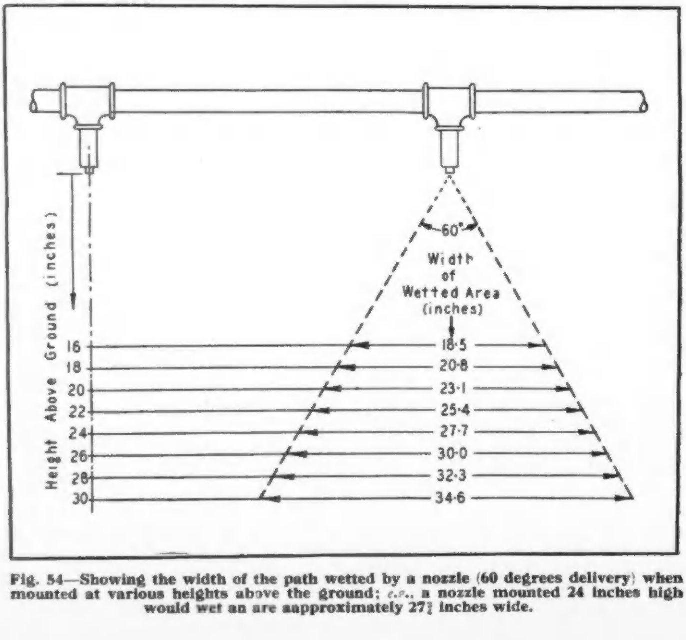


Fig. 54—Showing the width of the path wetted by a nozzle (60 degrees delivery) when mounted at various heights above the ground; *e.g.*, a nozzle mounted 24 inches high would wet an are aapproximately 27¾ inches wide.

care of any variations in row widths. A suitable nozzle will wet an area about 27 inches wide from a height of 22 to 24 inches above the soil. This, of course, varies somewhat and facilities for adjusting the height above the ground surface are desirable in order that the required amount of coverage is obtained.

Remember that with row spraying only about half the ground surface is covered and therefore this method uses only half the amount of chemical that is necessary for blanket spraying.

per hour approximately. Table 4 shows that 3/64 inch Greenhouse nozzles would be suitable at 30 to 40 lbs. pressure.

With the cone spray nozzles (Table 5) a larger size, *e.g.*, 5/64, would be barely adequate, since this would deliver approximately 19 gallons per hour at 30 lbs. pressure and 20 gallons at 35 lbs. pressure. In this case, if larger nozzles were not available, it may be necessary to make the spray solution slightly stronger or to run the tractor

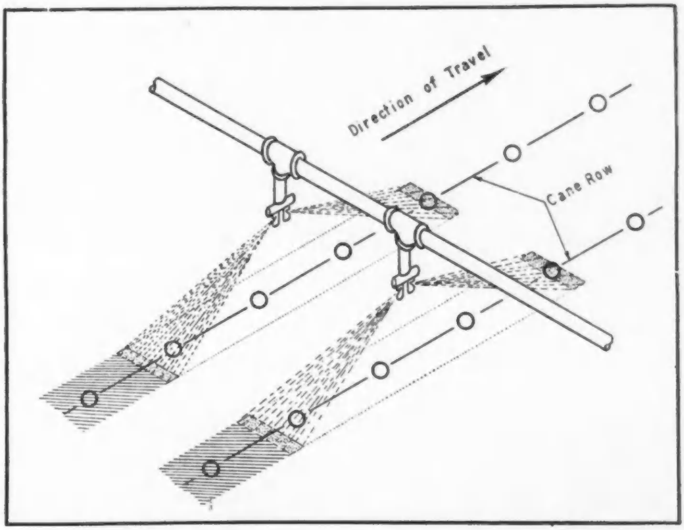


Fig. 55—Greenhouse nozzles fitted in pairs to throw forwards and backwards give excellent coverage.

Therefore some 10, 15 or possibly 20 gallons per acre of liquid will be used. By dividing the figures given in Table 1 by 2, this table can be used to obtain an approximation of the required capacity of the outfit. For instance, for row spraying, if it is desired to spray three rows at the rate of 10 gallons per acre with the tractor running at four miles per hour, then the spray equipment would need to have a delivery of $131 \div 2 = 65\frac{1}{2}$ gallons per hour. Since three nozzles would be used (one over each row) each nozzle would have to deliver $65\frac{1}{2} \div 3 = 21$ to 22 gallons

a little more slowly. Turning to Table 1 again, it will be seen that an output of $98 \div 2 = 49$ gallons per hour would suffice if the tractor were run at 3 miles per hour. In this case, three 1/16 inch spray nozzles would be adequate, since at 35 lb. pressure they would deliver $3 \times 16.6 = 49.8$ gallons per hour.

It should again be stressed that it is not possible to calculate the exact requirements and some trial and error methods will always be necessary before final adjustments are made. The figures given, however, will enable the components to be purchased with sufficient

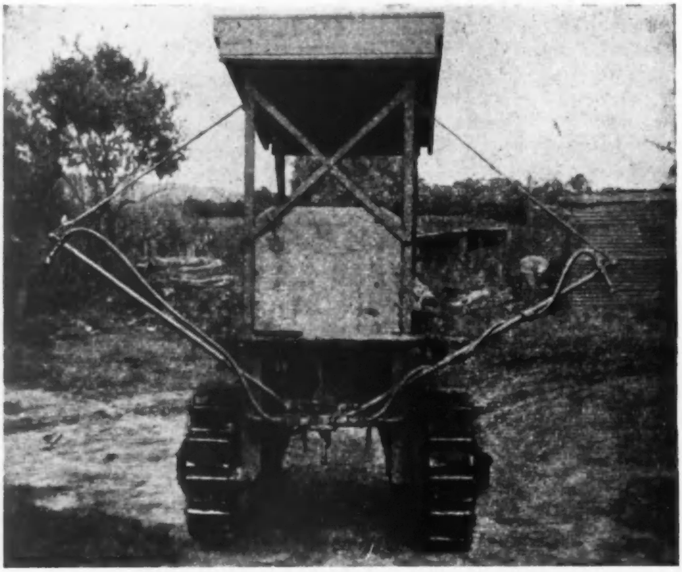
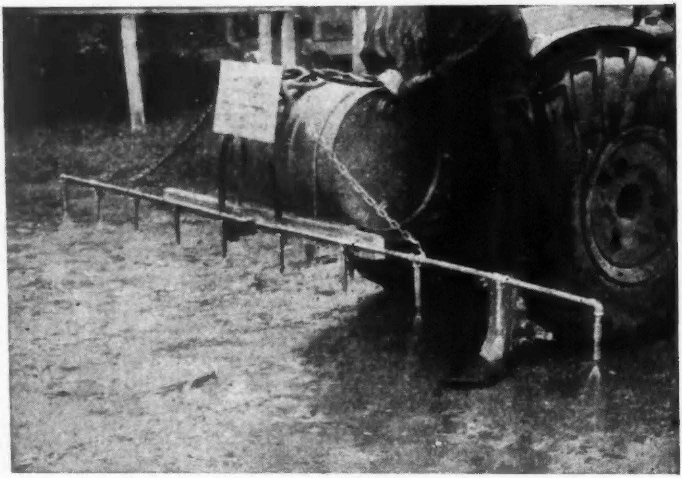


Fig. 56—Showing arrangement for lifting booms for turning. The ropes run over pulleys and may be operated from the driving seat. Note flexible hose connection to nozzles.



—Photo, Stacks Studio, Innisfail

Fig. 57—Each half section of boom is pivoted through a support of 3 x 2 hardwood by means of a blocked off elbow piece. Note flexible hose intake to boom from pump delivery line.

accuracy so that small alterations of tractor speeds or quantities of water used will bring the output well within the required limits.

In some farm built units a very satisfactory method of row spraying has been adopted by mounting the Greenhouse type of nozzle in pairs, so that one nozzle delivers its fan shaped spray in a forward direction and the other delivers backwards (Fig. 55). Of course, when using such an arrangement of paired nozzles, the delivery also will be doubled and this should be avoided by using nozzles with a smaller orifice than that which would be used if only one jet were fitted.

BOOMS AND PIPING

Galvanized piping of ½, ¾ or 1 inch diameter is suitable for booms, droppers and pump delivery and suction lines. For booms longer than about 15 feet the larger diameters are preferable, mainly because of its heavier nature and greater rigidity. However, if ½ inch piping only is available and it is desired to construct a boom to cover about six interspaces, it may be used providing it is well stayed by supporting wires or chains. Actually piping of this diameter when used for the boom itself will supply the nozzles without a great loss of pressure throughout the length, but it would be necessary in this case to use ¾ or 1 inch piping connecting the boom to the delivery side of the pump and also in the suction side to the container.

It is essential that the boom be made in two sections so that each may be pivoted near the middle line of the tractor. Such a provision is necessary so that the ends of the boom may be raised out of the way for travelling or turning (*see* Figs. 34, 56). A simple method of arranging the pivot is shown in Fig. 53 (inset) in which an elbow is threaded on to the boom end and extended to pass through a hardwood boom support (*see* Fig. 57 also). The extension is then blocked off by a screwed on cap. A large washer on either side of the hardwood allows easy movement. The liquid is introduced into the boom by a flexible hose from the pump delivery line.

With an outfit such as shown in Fig. 52 which is used for spraying the row only, the hardwood boom support is hinged directly behind each rear wheel of the tractor. The flexible hose coupling to the nozzles does not impede the necessary movement.

Stays.

Supporting wires or chains from the ends of the boom to some fixture on

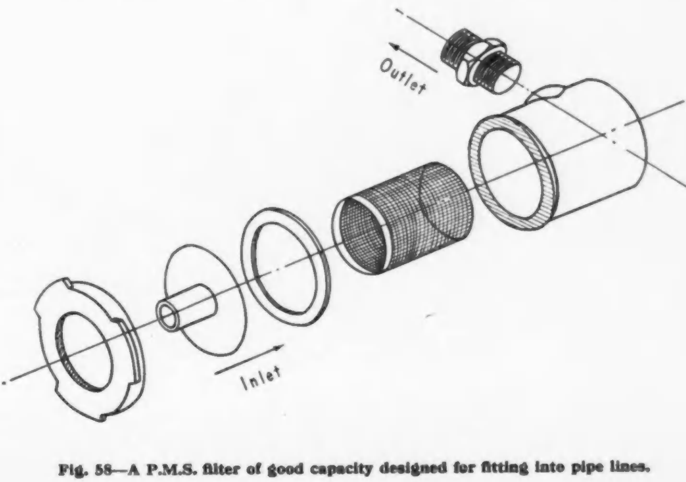


Fig. 58—A P.M.S. filter of good capacity designed for fitting into pipe lines.

the tractor will be required, particularly on the longer booms where considerable whipping will occur as the tractor moves along. Several of the accompanying photographs illustrate the various devices adopted. If these run over pulleys and lead to a position handy to the driving seat the booms may be raised or lowered without dismounting.

Droppers.

On most outfits it has been found convenient to use extension pieces of piping (*see* Fig. 53) between the boom and the nozzles. These droppers place the nozzles closer to the soil surface and give a better clearance for the boom and the brackets or frame on which it is mounted. In general, they are of the same diameter galvanised piping as the boom to which they are joined by screwing into tee pieces.

Filters or Strainers.

Suitable filters are essential. No matter what care is taken to have the liquid free from sediment before filling the tank, small particles will always be present which will ultimately cause nozzle blockage. In addition, it is impossible to be certain that no scale or pieces of rust will flake off from the inside of the container or pipes. A blocked nozzle means that part of the area will be missed by the spray and no weed control will be obtained thereon.

Fig. 48 shows a large filter inserted in the filler opening of the drum. This is cylindrical in shape forming a basket about 4 inches in diameter by 14 inches deep. A large filter of this type is convenient since the 2,4-D can be placed directly in the filter where it will be readily dissolved and mixed as the water passes through to fill the drum. A second strainer should be placed in the suction line fairly close to the pump as shown in Fig. 48 in order to take care of scale and accumulated sediment in the tank. A suitable type of filter for fitting in this position is the P.M.S. filter which is illustrated in Fig. 58. The outlet end can be screwed into the intake of the pump while the other side is connected to the pipe line by means of flexible hose and clamps. As a general rule the gauge of the strainer should be of slightly finer mesh than the aperture of the nozzle.

CONTAINERS

A suitable type of container for holding the spray liquid, and probably the most readily available, is a 44 gallon drum. For larger plants two of these have been satisfactorily mounted on the tractor. It should be noted that no pressure is developed in the container.

APPENDIX I.

METHOXONE AND 2,4-D AS CONTACT SPRAYS

The following table gives a list of plants which have been sprayed, and the responses which have been observed.

X = killed by one pound of active ingredient per acre.
XX = killed by two pounds of active ingredient per acre.
XXX = killed by three pounds of active ingredient per acre.
XXXX = killed by four pounds of active ingredient per acre.

I = results inconclusive.
R = resistant to all strengths of spray used.
N = chemical not tried.

These tests were carried out mainly on the Sugar Experiment Stations at Bundaberg, Mackay and Meringa. Where varying results were obtained at the different localities this is indicated in the remarks column.

Common Name	Botanical Name	Methoxone	2,4-D	Remarks
Star of Bethlehem (Cupid's Flower)	*Ipomoea quamoclit*	X	X	Very easily controlled by these Weedicides.
Bell Vine	*Ipomoea plebeia*	X	XX	Single strength 2,4-D not used.
Lesser swinecress	*Coronopus didymus*	XX	N	Only tried at Bundaberg.
Creeping knotweed	*Polygonum prostratum*	R	N	Only tried at Bundaberg.
Flannel weed	*Sida cordifolia*	X—I	XX—I	This weed killed at Meringa. Results inconclusive at Mackay, single strength 2,4-D not used.
Common Sida	*Sida rhombifolia*	I—R	I—R	Some killing of young plants at Bundaberg.
Prickly False Mallow	*Malvastrum coromandelinum*	I	I	Mostly killed at single to double strength at Bundaberg and Mackay, but showed recovery at Meringa.
Gomphrena weed	*Gomphrena celosioides*	I	I	Young plants killed at Bundaberg. Resistant at Mackay and Meringa.
Pink Burr	*Urena lobata*	XX	XX	Some recovery at Mackay. Single strength 2,4-D not used.
Star Burr	*Acanthospermum hispidum*	X—XX	XX	Some recovery at Mackay. Single strength 2,4-D not used.
Mexican clover	*Richardia scabra*	X	XX	Some recovery at Mackay. Single strength 2,4-D not used.
Goatweed	*Ageratum conyzoides*	X	XX	Prolific aerial roots on older plants. Single strength 2,4-D not used.
Tridax daisy	*Tridax procumbens*	XX	XXXX	This was the only strength of 2,4-D used.
Wild passionfruit	*Passiflora foetida*	R	N	Only tried at Meringa.
Sensitive plant	*Mimosa pudica*	R	R	Some XXXX with 2,4-D.
Asthma plant	*Euphorbia hirta*	XX	N	Killed at Mackay and Bundaberg. Not killed at Meringa.
Pig weed	*Portulaca oleracea*	X—I	XX—I	Frequently killed by single strength applications, but on occasions shows resistance.
Cape Gooseberry	*Physalis peruviana*	XXX—R	XXXX—R	

Common Name	Botanical Name	Methoxone	2,4-D	Remarks
Wild Cosmos	*Cosmos bipinnata*	X	XX	Only tried at Meringa, single strength 2,4-D not used.
Poona pea	*Vigna unguiculata*	X	XX	Only tried at Meringa, single strength 2,4-D not used.
Cusara pea	*Crotalaria usaramoensis*	I	I	Killed at Meringa. Resistant at Mackay.
Rattle pod	*Crotalaria striata*	N	XX	Only tried at Meringa.
Rattle pod	*Crotalaria trifoliastrum*	R	R	Only tried at Meringa.
Gambia pea	*Crotalaria goreensis*	R	R	Killed by single strength Methoxone in one trial at Meringa.
Mauritius bean	*Stizolobium atterimum*	XX	XX	Only tried at Meringa (single strength not used).
Calopo pea	*Calopogonium mucunoides*	XX	XX	Only tried at Meringa (single strength not used).
Noogoora burr	*Xanthium pungens*	X	X	Seeds of treated plants are also affected. Appears very susceptible.
Mexican poppy	*Argemone mexicana*	R	I	Some killing with 2 and 4 times normal strength 2,4-D.
Yellow Wood Sorrel	*Oxalis corniculata*	R	R	Some killing with 2 and 4 times normal strength 2,4-D.
Purple top	*Verbena bonariensis*	XX	XX	Only tried at Mackay (single strength not used).
Milk Thistle	*Emilia sonchifolia*	R	R	Only tried at Mackay.
Needle Burr	*Amaranthus spinosus*	R	R	Only tried at Mackay (usually susceptible).
Spiny Sida	*Sida spinosa*	R	R	Only tried at Mackay.
Blackberried nightshade	*Solanum opacum*	XXX	XXXX	Only tried at Mackay.
Virginian pepper cress	*Leopidium virginicum*	R	R	Only tried at Mackay.
Pseudo wild carrot	*Daucus carota*	R	R	Only tried at Mackay.
Green Amaranth	*Amaranthus viridis*	R	R	Only tried at Mackay.
Castor-oil plant	*Ricinus communis*	—	R	Only tried at Mackay (usually susceptible).
Lantana	*Lantana camara*	XX	XX	Only tried at Mackay (young growth treated).
Cudweed	*Gnaphalium purpureum*	XX	XX	Only tried at Mackay (single strength not used).
Apple-of-Peru	*Nicandra physaloides*	R	N	Only tried at Mackay.
Swamp nut or Sedge	*Cyperus Sp.*	XX	N	Only tried at Mackay.
———	*Eclipta alba*	R	N	Only tried at Mackay.
Red headed cotton bush	*Asclepias curassavica*	R	N	Only tried at Mackay.
Cobbler's Peg	*Bidens pilosa*	XX	XX	Single strength not used.
Lucerne	*Medicago sativa*	XX	N	Only tried at Bundaberg.
Swamp dock	*Rumex brownii*	XXX	XXXX	Only tried at Bundaberg.
Tah vine	*Boerhaavia diffusa*	I	I	Only tried at Bundaberg. Young plants killed, some killing of older plants, also some recovery.
Crownbeard or Wild Sunflower	*Verbescina encelioides*	N	XX	Only tried at Bundaberg.
Khaki Weed	*Alternanthera repens*	X	XX	Only tried at Bundaberg, single strength 2,4-D not used.
Cane Killing Weed	*Striga sp.*	N	X	
Nut grass	*Cyperus rotundus*	R	R	Foliage killed but re-growth appears after repeated sprayings.
Wild Heliotrope or Turnsole	*Heliotropium amplexicaule*	R	R	Some damage to foliage, but full recovery follows.

The Effect of Krilium on Some Sugar Cane Soils

By L. G. VALLANCE and K. C. LEVERINGTON.

An article dealing with the technical details of this investigation has been prepared for submission to the Eighth Congress, International Society of Sugar Cane Technologists.—ED.

It may be recalled that in the October, 1952, issue of this Bulletin (p. 52) reference was made to the fact that the Bureau has been able to obtain a small amount of " Krilium," with which it was proposed to carry out experiments to determine its effect on some of our sugar growing soils. A considerable amount of work has now been carried out and it is felt that the results will be of interest to growers in many areas.

It should be explained that Krilium is the trade name for a complex organic chemical made by the Monsanto Chemical Co., United States. It may best be described as a soil *conditioner, i.e.*, it has the power to improve the physical condition of the soil. The tendency of certain soils to " set " and form hard clods is prevented and the soil will remain friable and mellow. At the same time it causes the soil to become loose and open so that drainage is improved, irrigation and rain water can enter the soil more readily, and there is a better supply of air to the plant roots. Krilium, however, is not a fertilizer since it does not supply the plant foods which must be present in adequate amount for the growth of the crop. It is used merely to improve soil tilth, which of course is a most important property of a soil.

The way in which Krilium works may be of interest to those growers who like to know the why and wherefore of such things. Actually a Krilium particle may be regarded as being made up of a number of atoms strung together and forming a series of threads. Along these threads occur quite a number of negative electrical charges. These electrical charges attract the small particles of clay and a number will come together and form a cluster or small lump. This causes a soil to take on a granular structure in which the clay particles aggregate together in a manner somewhat resembling grains of sand. These grains do not melt away when wet and since they persist with a considerable degree of permanence the soil is maintained in a crumbly condition and loses its tendency to set hard on drying out. The number of aggregates formed can be readily determined by washing the soil through a sieve. If the aggregates break down under the action of the water they will pass through the holes in the sieve. The aggregates which do not pass through are regarded as being stable to water, and it is these which are of importance in the field from the point of view of practical farm cultivation operations. By measuring the number of water-stable aggregates in a soil before and after treatment with Krilium a very useful measure of the effect of the conditioner may be obtained.

Three sugar soils which are difficult to farm were selected for testing. These were a silt loam from the Burdekin area, a clay loam from Mossman, and another from Fairymead. All three contain a high clay content, are very intractable, and hard to cultivate or to prepare for planting. To drain them adequately is a problem, as also is the efficient application of irrigation water. Their behaviour under the influence of Krilium was most interesting, and is as follows.

Burdekin Silt Loam.

This soil showed a remarkable improvement in physical condition when treated with Krilium in the laboratory. After the Krilium had been added, the samples were puddled with water and then allowed to dry. The

untreated soil set very hard and great difficulty was experienced in breaking up the lumps by hand. The treated soil, however, did not set in a hard clod, but remained friable and granular. This is illustrated very clearly in Fig. 59, in which the hard lumps of untreated soil at the top of the picture are sharply contrasted with the much better physical condition of the soil which had received Krilium at the rate of 500 lb. per acre.

In addition to observing the beneficial effect on the appearance and feel of the soil, measurements were made of the

Fig. 59—Burdekin Silt Loam. The sample at the bottom has received an application of Krilium equivalent to 500 lb. per acre to a depth of about four inches. Note the loose, friable, crumbly condition as compared with the hard cloddy nature of the untreated soil at the top of the picture.

increase in the content of water-stable aggregates formed by the action of the Krilium. This was done by using amounts of Krilium varying from 150 lb. to 750 lb. per acre. The results are given in Table I.

TABLE 1

Burdekin Soil

Amount of Krilium used lb. per acre	Percentage of water stable aggregates
nil	1
150	3
300	11
450	30
600	57
750	70

It will be seen from the above figures that this soil in its original condition contained only 1 per cent. of particles which would not break down when wet. The other 99 per cent. of the soil melted into a sloppy mass on wetting which would set into a clod on drying. Howevery, when Krilium was added the whole character of the soil changed rapidly. With 150 lb. per acre, the water-stable aggregate content increased to 3 per cent. After this it rose rapidly and an application of 750 lb. per acre resulted in 70 per cent. of the soil being completely aggregated.

Mossman Clay Loam.

As with soil from the Burdekin, this Mossman soil was greatly improved by the addition of Krilium. It was transformed from a soil which was very difficult to work to one which had all the characteristics associated with a good loamy condition. The amount of improvement may be gauged from the increases that occurred in the percentage of water-stable aggregates. These are given in Table II.

Although less than 1 per cent. of this soil was aggregated under natural conditions the heaviest application of Krilium caused over half of it to form particles which remained stable wheu wet.

TABLE 2

Mossman Soil

Amount of Krilium used lb. per acre	Percentage of water stable aggregates
nil	less than 1
150	3
300	3
450	23
600	46
750	53

Fairymead Clay Loam.

The behaviour of this soil indicated that these new soil conditioning substances should not be used indiscriminately. The figures given in Table III show that Krilium did not improve this soil in so far as the content of aggregates was concerned. In fact, the sample which had the best granulation was the one which received no treatment.

TABLE 3

Fairymead Soil

Amount of Krilium used lb. per acre	Percentage aggregation
nil	55
150	42
300	39
450	42
600	45
750	50
1050	43
1350	50

In this experiment the large amount of 1,350 lb. per acre was applied and still no increase was obtained. These results were most unexpected, since other work had indicated that the type of clay present in the Fairymead soil was very similar to that of the Burdekin soil which had shown an excellent response to Krilium. However, although no improvement was apparent from measuring aggregate content, there was a suggestion, throughout the treatments, of a beneficial response in the " feel " of the soil. It is intended to pursue this aspect further in a field trial as soon as larger quantities of Krilium come to hand.

Conclusion.

The laboratory tests on the soil samples from the Burdekin and Mossman districts indicated that a very great improvement in physical condition may be confidently expected from the use of Krilium and other similar soil conditioning substances. On other soils, such as the particular Fairymead soil from the Bundaberg district, it would appear that the beneficial effect is somewhat doubtful. However, it must be realised that it is not always possible to relate laboratory findings closely to what actually happens in the field. This is particularly true in so far as the amounts that are required per acre to give sufficient improvement for practical purposes are concerned. Therefore field trials are necessary, and these will be carried out with a great deal of interest when increased supplies of the conditioner are available.

At the time of writing the material is not on the market in Australia in quantities or at prices that would interest the cane grower. Krilium is being sold in the United States at over ten shillings per pound. An average dressing is about 300 lb. per acre, and therefore, of course, at the moment, its usage on a farm scale is not an economic proposition. Nevertheless, events in the last few years give ample evidence of the chemical industry's ability to manufacture large quantities of organic chemicals within a price range that permits economical farm application. Instances which immediately come to mind are benzene hexachloride, hormone weedicides and mercurial dipping materials. Undoubtedly these new soil conditioners are something farmers have been seeking for many years and there should be an assured market provided they can be produced cheaply enough. They should be extremely useful in renovating bad patches due to poor physical conditions in an otherwise good field.

The Value of Molasses

By NORMAN J. KING

The growing interest of cane farmers in molasses as a fertilizer prompts this short article on its analyses, value and properties. The plant food content of molasses varies according to the composition of the cane being crushed at a factory and this is related to the soil type on which the cane was grown as well as to the fertility of that soil. It follows therefore that the molasses from a given mill will vary somewhat in analysis during the season and that molasses from different factories will not have exactly the same composition.

For the purposes of this article an average has been taken of the analyses of a large number of molasses samples from various mills in Queensland, over a period of years. It is found as a result of converting such figures to fertilizer equivalent that one ton of molasses contains nitrogen, phosphoric and potash equivalent to

90 lb. Sulphate of ammonia
22 lb. Superphosphate
and 110 lb. Muriate of potash.

At present day fertilizer values (f.o.b. Brisbane, October, 1952), these amounts of fertilizer would cost £3/10/-. This amount would be subject to freight charges, and when these are added it is found that in the principal centres of cane growing the cost would be

Cairns ..	£3/16/3
Mackay	£3/15/2
Bundaberg	£3/13/10

There are certain allowable discounts for cash which have not been taken into consideration.

It is reasonable, therefore, to assess the fertilizer value of molasses of the above composition at the cost of equivalent fertilizer, the molasses being at the mill and the fertilizer at the wharf or railhead in the respective towns. In either case the material,

whether molasses or fertilizer, is still subject to transport charges to the farm.

It is not practicable to continue the comparison of costs beyond this point. The charges made for transport and spreading of molasses vary from district to district, and in some cases the charges are equalized to prevent discrimination against far distant growers. In some areas the cost of transport and distribution is included in the price of the molasses. It is apparent, therefore, that each district has to be considered separately, and cognisance taken of the method of charging.

Additional to actual fertilizer value, the Bureau has always claimed that molasses possesses particular properties which, unit for unit, make it superior to fertilizers in producing cane tonnage. This may not be the case on all soils and under all conditions, but it has given such results in several of the Bureau's field trials. When applied to the soil the molasses is immediately attacked by fungi which use it as food and which, in consequence, build up temporarily an enormous population. When the food supply is depleted most of the fungi die, and during the decomposition of their cells the plant foods absorbed from the molasses are made available to the cane crop.

Molasses is not a well balanced fertilizer. On the basis of the above figures a 5-ton per acre application would contain the equivalent of

450 lb. Sulphate of ammonia (say 4 cwt.),
110 lb. Superphosphate (say 1 cwt.)
550 lb. Muriate of potash (say 5 cwt.).

There is ample sulphate of ammonia to grow a large cane crop, far more than sufficient potash, but the superphosphate may be low, depending on the soil requirements. As a means of comparison it may be stated that the following amounts of sulphate of ammonia, superphosphate and muriate of potash are contained in 4 cwt. of the various Sugar Bureau Mixtures:

Mixture	Sulphate of Ammonia equivalent	Superphosphate equivalent	Muriate of Potash
No. 1 Planting	21¾	366½	56
No. 1 Ratooning	92½	300	47
No. 2 Planting	27¼	300	112
No. 2 Ratooning	92½	254½	93½
No. 3 Planting	38	214	187
No. 3 Ratooning	92½	178	168

It will be seen that on soils which are normally well supplied with phosphates and on which the use of Sugar Bureau No. 3 Mixtures is recommended the phosphate in a 5-ton application of molasses is sufficient for crop requirements. On other soils, where the No. 1 and No. 2 Mixtures are required, it would be desirable, and in some cases essential, to use two or three hundredweights of straight superphosphate to make up the molasses deficiency.

The quantity of potash in a 5-ton molasses application is ample for at least three cane crops on any soil type. Growers who apply molasses at this rate per acre need consider only the maintenance of a correct phosphate level in the soil by dressings of superphosphate and the use of sulphate of ammonia as a top dressing in the second and third crops.

There is nothing to be gained by using molasses in quantities heavier than five tons per acre. In the higher rainfall belt in particular much plant food is lost by the leaching action of heavy rains. A high concentration of plant foods may not persist in the soil over a long period, but be dissolved and removed beyond the zone of root feeding. Two five-ton applications at four-yearly intervals would keep the soil in a better nutritional state than would one ten-ton application over the same period.

The Burning Question

By J. H. BUZACOTT

In recent years many complaints have been heard of crops which although standing upright at harvest time lodge badly during the pre-harvest fire. This is particularly so in canes which trash freely. In well-grown stands of such varieties the trash is shed during the growth of the crop and lies round the base of the stools. The intense heat caused by the burning of a dense mass of trash at the base and the weight of the lengthy stalks causes bad lodging of the cane. If a hot fire is applied to any point of the green stalks of a plant it normally softens and bends easily. This is the principle used for centuries by primitive peoples in bending bamboos and lawyer cane for the fabrication of furniture and other articles. In cane varieties which do not shed their trash a much cooler fire occurs because the same amount of trash is spread over a larger area. Due to the better distribution of the fire the stalks are also more uniformly heated.

One reason that lodging troubles are very much greater now than they were a few years ago is that lengthier varieties, and undoubtedly higher yielders, are now grown. Recent varieties in which it is particularly liable to occur are Q.44, Q.50, and the new cane Q.57 which is undergoing propagation. These varieties all shed their trash very freely in big crops. It is accordingly advisable to take all possible precautions against lodging when harvesting heavy crops of them. The obvious solution is to harvest green, but where circumstances preclude this then the coolest fire possible should be used. In such instances it is usually advisable to burn later in the evening or early in the morning when there is dew on the trash. Never under any circumstances should crops of this nature be burnt during the afternoon or early in the evening after a hot day, since under those conditions lodging is inevitable.

It should be noted that these remarks only apply to varieties which shed their trash and habitually collapse during burning. In varieties which do not suffer in this way a hot fire is often desirable. Indeed, in a few canes such as Trojan, difficulty is normally experienced in getting an adequate burn, particularly on river flats, where often a rank growth of blue top occurs

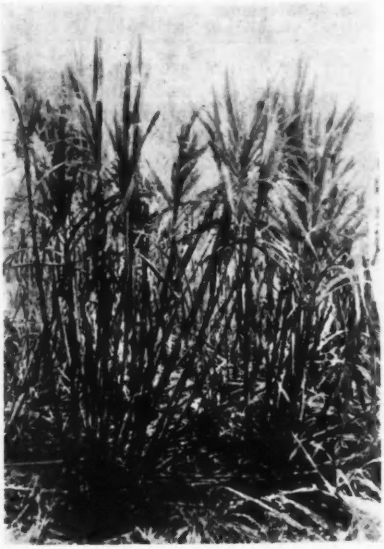


Fig. 60—Result of a comparatively cool morning burn.

among the cane. In this particular variety the trash remains attached to the cane but it has a tendency to curl on drying. The comparative lack of cover due to the curled dead trash is followed by a growth of blue top, and this has a deadening effect on the fire. It is wise to burn such crops as these when they are at their driest, and even during the middle of the day, if mill regulations permit and there is no fear of igniting an adjoining crop.

The accompanying pictures show the effect of burning adjoining sections of the same crop at different times. Figure 60 shows the result of a hot early evening burn, whilst Figure 2 shows the result of a comparatively cooler morning burn. The crop pictured was in the region of 60 tons per acre and the intense heat of the evening fire is indicated by the greater scorching of the foliage which shows in Figure 60 when compared with Figure 61.

Fig. 61—Result of a hot early evening burn.

Cultures for Green Manure Crops

One of the free services rendered by the Bureau to Queensland cane growers is the supply of cultures for treatment of seed of green manure crops before planting. This treatment is desirable to ensure that the organism responsible for collecting nitrogen for the use of the plant is present in the soil. When the culture is posted to the grower it is freshly prepared and is accompanied by instructions for its use.

Cultures lose their efficiency if kept for lengthy periods, but will retain their effectiveness for about four weeks if stored in a cool, dry place. Since weather conditions may prevent the farmer treating and planting his seed immediately the culture is received the Bureau will forward only freshly prepared material. Some time is necessary for its preparation and growth, and applications for cultures should be made at least a fortnight before they are required. It is not practicable to forward cultures immediately on receipt of telegraphic requests. The cultures are bacterial growths which require a period of many days for proper development.

N.J.K.

Trends in BHC Usage for Grub Control

By R. W. MUNGOMERY

It will be recalled that it was on the Meringa Sugar Experiment Station in 1946 that the first successes were obtained with benzene hexachloride (BHC) against cane grubs in Queensland. The destruction of the pest in the BHC-treated rows was so complete when compared with the adjacent untreated check rows that it immediately became evident that we had in our hands a new insecticide of outstanding value to the sugar industry. Possibly its full significance was not fully appreciated even then, for it would have been difficult to visualise such a rapid and successful expansion in pest control operations as has since taken place. Although only six years have elapsed since the first successful results were obtained, the reliability of this material as a grub destroyer has been demonstrated on so many subsequent occasions that cane growers are no longer willing to take the slightest risk of incurring damage to their crops, and it is now standard practice to apply BHC in all areas where damage by greyback or frenchi grubs is likely to occur. In last year's campaign against these pests a total of 51,000 acres was given a protective dressing with BHC either to the plant or ratoon crops, and this represented an outlay by the growers of over £200,000. Although grub infestation fluctuates from year to year an annual expenditure of a sum approximating this amount is now a normal expectation, and with so much money involved it is only natural that a keen watch is maintained on BHC prices, so that the industry is not called on to pay more than its fair share for pest control.

When BHC was first made available to the sugar industry it was formulated as a 10 per cent. dust on a pyrophyllite base. Because of the tendency of this dust to "fly" a request was made to substitute a heavier carrier, and as a result rock phosphate is now widely used as the diluent. This dust was marketed at 10d. per lb., and on a one-crop basis it became customary to apply 100 lb. of 10 per cent. BHC (1.3 per cent. gamma isomer) per acre. From the viewpoint of securing an even distribution of the insecticide this proved a convenient amount to apply per acre and there was no incentive to use half the quantity of the 20 per cent. BHC dust, which at that time was twice the price of the 10 per cent. product. Since then, however, the discovery that BHC was relatively stable when incorporated in the soil meant that grub control no longer had to be considered on the basis of one crop, but on the basis of three crops which is the normal cropping cycle in Queensland; and protection for this longer period was achieved by applying 150 lb. of 10 per cent. BHC dust per acre. Concurrent with this discovery the price of the 20 per cent. product was reduced —at one stage as low as 1/0½ per lb.— so it became more profitable to apply 75 lb. of 20 per cent. BHC dust than 150 lb. of the 10 per cent. product. Moreover an application rate of 75 lb. per acre presented no distribution difficulties, so the use of a 20 per cent. BHC (2.6 per cent. gamma isomer) dust became standard throughout most cane field areas that are subject to grubs, and at the present time this dust is being supplied to Cane Pest and Disease Control Boards at 1/5 per lb.

The ordinary crude BHC as it is produced is somewhat waxy in texture and consists of a number of substances which although they have the same chemical composition, differ markedly in their physical behaviour. One of these, the gamma isomer, which is present to the extent of 13 per cent., is the only substance that is highly toxic to insects and it has therefore always been a matter for some thought why all the worthless material should have to be transported thousands of miles incurring considerable freight charges when the more refined gamma product

could be forwarded and mixed at a place more centrally situated in respect of the areas liable to grub infestation. The answer, of course, is that the very pure gamma product is costly to refine and the high refining costs would more than offset the savings on freight charges. Hence up to the present the crude BHC has been used almost exclusively in the manufacture of dusts containing 2.6 per cent. gamma isomer.

From information gathered regarding the refining processes, it appears that, provided the degree of refining is not pursued beyond a gamma isomer concentration of approximately 70 per cent., the cost of this partial refining (and hence the cost of the final product) may not be unduly high.

In this connection we have had price quotations of from 16/- to 19/- per lb. for a 58-60 per cent. gamma isomer product. This means that for greyback grub control on a three-crop basis the requirements per acre would be 3¼ lb., which would place the cost per acre for the gamma BHC material at between £2/12/- and £3/2/-. To this, of course, would have to be added the cost of the carrier and containers, and the mixing, packing and distribution charges. **Some of this material was recently imported by the Bureau from Europe for trial purposes.** Unlike the waxy crude BHC, this proved to be a fine white crystalline substance resembling a good table salt in texture, and there appeared good grounds for believing that it would not present any serious problems when being ground or mixed with a suitable carrier for the manufacture of dusts of the standard gamma isomer content.

Samples have also been obtained from local manufacturers and experiments are now under way to compare the relative efficiencies of equivalent amounts of the partially refined and crude products in so far as grub control is concerned, whilst their effects on the growth of the cane plant itself are being closely watched. It is expected, however, that the use of the more highly refined product will eventually displace the crude BHC.

Now that BHC manufacture in Australia has been stepped up to meet local requirements it is a moot point whether licences will be granted for the importation into the Commonwealth of any large quantities of partially refined gamma BHC. Moreover, it is doubtful whether, without some form of protection, local manufacturers could compete in price with BHC imported from low-wage countries. However, it is pleasing to learn that by increasing the size of the BHC plant in Australia and manufacturing continuously throughout the year overhead costs have been spread and it will be possible to reduce the price of BHC dusts to Cane Pest and Disease Control Boards. An announcement along these lines is expected in the near future.

Lower Burdekin Sugar Experiment Station

By G. A. CHRISTIE

The need for an Experiment Station in the Lower Burdekin cane growing area has been evident to the Bureau and to cane growers in the district for many years; for in the selection and testing of new varieties, experiments should be conducted under conditions comparable with those of the district for which the varieties are required, if maximum benefit is to be achieved. In selecting a site, one of the most mportant considerations was that the soil should be typical of the area to be served by the Station. In addition, the land was required to be as free as possible from irregularities, so that a true comparison between varieties or treatments in small plots could be obtained. An area centrally placed in the district was sought, but this proved to be a difficult proposition in the closely settled Burdekin delta. Freedom from flooding was also essential, for major river floods could damage permanent installations and perhaps cause the loss of new varieties, or affect seriously the results of trials. A number of properties was examined and rejected before the present site, which was considered suitable, was purchased from Pioneer Sugar Mills (Pty.) Ltd. at the end of 1947.

The Experiment Station, situated about seven miles west of Ayr, comprises almost 90 acres of typical delta soil, a comparatively small portion of which is unsuitable for cultivation. An assignment of 64 acres gross and 48 acres nett was granted, and this should provide ample scope for experimental work for many years.

Fig. 62—Varietal trial on the Lower Burdekin Sugar Experiment Station

Naturally one of the first essentials for an Experiment Station in the Lower Burdekin was an adequate supply of good irrigation water, and before the property was purchased ten holes were bored in different places to test the quality of " drift." The first six proved quite unsatisfactory, but later bores located an excellent water supply and allowed the Station pumping plant to be sited conveniently.

Soon after the land was purchased plans for the early development of the Station were prepared, though many delays occurred in obtaining all types

of materials, for it will be remembered that the years 1948, 1949 and 1950 were difficult ones for the purchasing of items essential for a project of this type. A contour survey showed some irregularity in the land surface, but it indicated that careful grading would produce an excellent irrigation slope over most of the area. Since the land borders on grazing country, a good stock proof fence was erected to replace the old existing fences, which were in bad condition.

The early history of this land indicated that cane is not a new crop on the property, for cane was grown on the Station site by Kanaka labour some sixty-five years before, though sugar production was abandoned about twenty-five years later. From this it

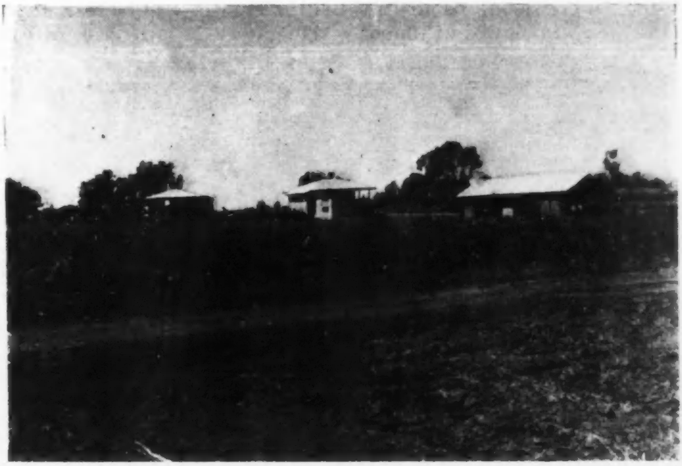


Fig. 63—Residence, Laboratory and Implement Shed recently erected on the Station

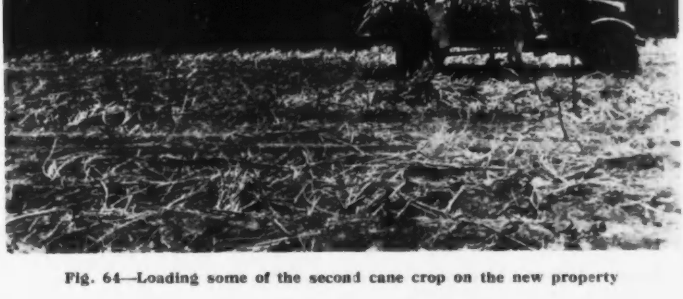


Fig. 64—Loading some of the second cane crop on the new property

will be seen that the area which now forms the Experiment Station was one of the first properties to be planted with sugar cane in the Burdekin district. Indeed, while levelling one of the old irrigation ditches which remained from its earlier sugar period, parts of an old steam engine, boiler, etc., and pieces of an old cable plough were unearthed. The remains of old cane drills, six to eight feet apart, can be seen in some of the uncultivated grassland. As a result most of the area was cleared of timber and the small timbered area which was required for cultivation has since been brought under crop.

A residence for the officer-in-charge of the Station was completed early in 1950, and although shortages of materials caused delays in completing the irrigation unit, water was available for the first planting on the Station in autumn of that year. The unit consists of a 6-7 inch centrifugal pump direct coupled to a 40 h.p. electric motor and operating from three 6-inch spears. It is located in a shallow concrete well, which is sealed to prevent the entry of water in flood times, and is provided with a weather-proof shed set on a concrete base. Water is reticulated to various blocks on the Station through underground 15-inch concrete pipe, suitable outlets being fitted along its 42 chains of length. An implement shed was completed late in 1950 and the most recent structure, completed during 1952, is a laboratory-office building which provides office accommodation for the two Bureau officers stationed in this area, and a laboratory where investigational work on many phases of cane growing can be carried out. This laboratory is provided with a small sample crushing mill, which has already proved useful for analysing variety and other plot cane samples, as well as samples submitted by cane growers.

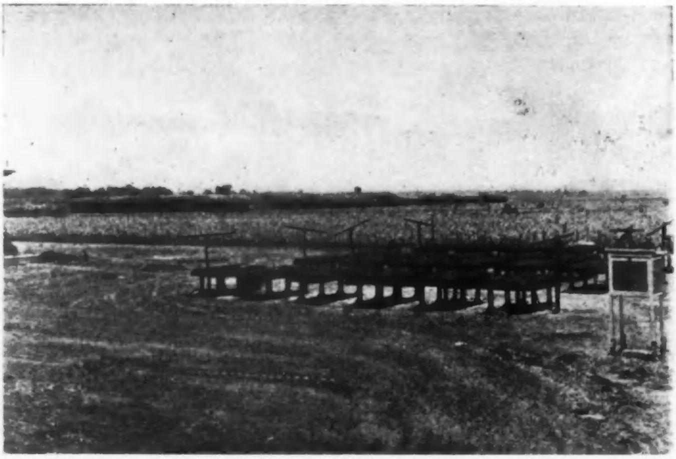


Fig. 65—Concrete seedling benches on the new station. Over 6,000 seedling canes were planted out last year

The first Station crop was planted in autumn 1950, comprising nearly nine acres of standard varieties for plants, some new canes introduced through isolation plots from other districts, and 3,199 original seedlings. Plantings in both 1950 and 1951 were restricted by shortages of labour. In 1951 the number of original seedlings was increased to 6,240; the total area planted for the year was about eight acres, and with approximately four acres of ratoons from the previous year, some 12 acres were harvested for milling in 1952.

1952 planting amounted to twenty-four acres, including 6,384 original seedlings, and there is in addition four and a half acres of ratoons. This area includes propagation plots and variety trials in which standard varieties are compared with seedlings selected from the Lower Burdekin Station's previous plantings, as well as varieties from other districts and from other countries. Apart from the 6,384 original seedlings, each one of which is a new variety, there are a total of 271 other varieties on this Station at the present time. These comprise five standard varieties for comparison with the new canes, 136 varieties selected from seedlings grown on the Lower Burdekin Station, 32 varieties introduced through quarantine plots from other districts, and 98 varieties introduced from other countries.

The total of 28½ acres under cane for 1953 harvest is growing in eight small blocks and the total number of plots, either as varieties or different treatments, amounts to 523.

The difficulty in obtaining suitable farm labour in the past has brought about a slower development of this Station than was desired, but it is hoped that in future years the Lower Burdekin Sugar Experiment Station will expand, and that the services to cane growers in the area will be increased.

The Poverty of Some New Lands

During the past few years much new land previously clothed with scrub, forest or grass has been assigned and cleared for cane growing. The old belief that all virgin land is rich land still persists, and the majority of new growers—and old growers extending their cultivated areas—have not troubled to have soil analyses carried out. In many such cases the first plantings of cane are likely to be disappointing.

During the settlement of returned soldiers within the "Sugar Industry Land Settlement Act of 1946" there have been many examples of this unexpected soil poverty. Portions of the Utchee Creek land near South Johnstone were found to be low in available plant foods despite its apparent similarity to the other red soils of that area. The North Isis soldier settlement, although carrying heavy forest, needed fairly heavy fertilizing in its first year. Some of the newly assigned lands adjacent to Bundaberg are extraordinarily poor in available plant food supply.

This is not a new experience in the sugar belt. Early settlers in Babinda will recall that the majority of farms needed fertilizing in the second year after clearing the scrub; the apparently rich soil of Goodwood, near Childers, would not produce a plant crop of Uba the first year after clearing, and a similar condition was experienced at Alloway, near Bundaberg. In the two last mentioned cases the soil was found, on analysis, to contain practically no available phosphoric acid, but the deficiency was soon corrected with adequate dressings of superphosphate.

The sugar industry, as a result of expansion, is spreading outwards from the previous centres of cane growing. The early settlers naturally selected their land with one eye on the quality of the soil and the other on the location of the mill. In many cases the lands being taken up to-day are less fertile and it is to be expected that plant food deficiencies may be more common. Fortunately modern science can detect such plant food shortages very rapidly and a recommendation can be given as to the correct type and quantity of fertilizer to use.

Although the Bureau never ceases to urge existing growers to take advantage of its free soil testing service, it makes a special appeal to settlers taking up new land to send soil samples in for an analysis and report. The industry needs all the cane that can be grown and at the same time a new grower can ill afford crop failures in his first plantings.

N.J.K.

"THE SUGAR EXPERIMENT STATIONS ACTS, 1900 to 1952"

List of Varieties of Sugar Cane Approved for Planting, 1953

Bureau of Sugar Experiment Stations, Brisbane, 1st January, 1953.

Mossman Mill Area.

Badila, Cato, Clark's Seedling, Comus, Pindar, P.O.J.2878, Pompey, Q.44, Q.50, S.J.4, and Trojan.

Hambledon Mill Area.

Badila Badila Seedling, Cato, Comus, Eros, Pindar, Pompey, Q.44, Q.50, and Trojan.

Mulgrave Mill Area.

North of Fig Tree Creek.

Badila, Badila Seedling, Cato, Clark's Seedling, Comus, Eros, Pindar, P.O.J.2878, Q.44, Q.50, S.J.4, and Trojan.

Babinda District.

Badila, Badila Seedling, Cato, Clark's Seedling, Comus, Eros, Pindar, Q.44, Q.50, S.J.4, and Trojan.

Babinda Mill Area.

Badila, Badila Seedling, Cato, Clark's Seedling, Comus, Eros, Pindar, Q.44, Q.50, and Trojan.

Goondi Mill Area.

Badila, Badila Seedling, Clark's Seedling, Pindar, Q.44, Ragnar, Trojan, and Vidar.

South Johnstone Mill Area.

Badila, Badila Seedling, Clark's Seedling, Eros, Pindar, Q.44, Q.50, S.J.4, and Trojan.

Mourilyan Mill Area.

Badila, Badila Seedling, Clark's Seedling, Eros, Pindar, Q.44, Q.50, S.J.4, and Trojan.

Tully Mill Area.

Badila, Badila Seedling, Clark's Seedling, Eros, Pindar, Q.44, Q.50, and Trojan.

Victoria Mill Area.

Badila, Eros, Pindar, Ragnar, and Trojan.

Macknade Mill Area.

Badila, Eros, Pindar, Ragnar, and Trojan.

Invicta Mill Area.

North of Townsville.

Badila, Comus, Eros, Pindar, P.O.J. 2725, Q.50, Ragnar, and Trojan. The variety Clark's Seedling may be planted only in the section south of Cattle Creek.

South of Townsville.

Badila, B.208, Clark's Seedling, Comus, E.K.28, Pindar, P.O.J.2714, S.J.2, S.J.4, S.J.16, and Trojan.

Inkerman District.

Badila, B.208, Clark's Seedling, Comus, E.K.28, Pindar, P.O.J.2878, S.J.2, S.J.16, and Trojan.

Pioneer Mill Area.

Badila, B.208, Clark's Seedling, Comus, E.K.28, Pindar, P.O.J.2878, S.J.2, S.J.16, and Trojan.

Kalamia Mill Area.

Badila, B.208, Clark's Seedling, Comus, E.K.28, Pindar, P.O.J.2878, S.J.2, S.J.16, and Trojan.

Inkerman Mill Area.

Badila, B.208, Clark's Seedling, Comus, E.K.28, Pindar, P.O.J.2878, S.J.2, S.J.16, and Trojan.

Proserpine Mill Area.

Badila, C.P.29/116, Clark's Seedling, Co.290, Comus, E.K.28, M.1900 Seedling, Pindar, P.O.J.2878, Q.28, Q.45, Q.50, and Trojan.

Cattle Creek Mill Area.

Badila, Badila Seedling, Clark's Seedling, Co.290, Comus, E.K.28, M.1900 Seedling, Pindar, P.O.J.2725, P.O.J.2878, Q.28, Q.45 Q.50, and Trojan.

Racecourse Mill Area.

Badila, Badila Seedling, Clark's Seedling, Co.290, Comus, E.K.28, M.1900 Seedling, Pindar, P.O.J.2725, P.O.J.2878, Q.28, Q.45, Q.50, and Trojan.

Farleigh Mill Area.

Badila, Badila Seedling, Clark's Seedling, Co.290, Comus, E.K.28, M.1900 Seedling, Pindar, P.O.J.2725, P.O.J.2878, Q.28, Q.45, Q.50, S.J.2, and Trojan.

North Eton Mill Area.

Badila, Badila Seedling, Clark's Seedling, Co.290, Comus, E.K.28, M.1900 Seedling, Pindar, P.O.J.2725, P.O.J.2878, Q.28, Q.45, Q.50, S.J.2, and Trojan.

Marian Mill Area.

Badila, Badila Seedling, Clark's Seedling, Co.290, Comus, E.K.28, M.1900 Seedling, Pindar, P.O.J.2725, P.O.J.2878, Q.28, Q.45, Q.50, and Trojan.

Pleystowe Mill Area.

Badila, Badila Seedling, Clark's Seedling, Co.290, Comus, E.K.28, M.1900 Seedling, Pindar, P.O.J.2725, P.O.J.2878, Q.28, Q.45, Q.50, S.J.2, and Trojan.

Plane Creek Mill Area.

Badila, Badila Seedling, Clark's Seedling, Co.290, Comus, E.K.28, M.1900 Seedling, Pindar, P.O.J.2725, P.O.J.2878, Q.28, Q.45, Q.50, and Trojan.

Qunaba Mill Area.

C.P.29/116, Co.290, Pindar, P.O.J. 2878, Q.42, Q.47, Q.49, Q.50, and Q.55.

Millaquin Mill Area.

C.P.29/116, Co.290, Pindar, P.O.J. 2878, Q.42, Q.47, Q.49, Q.50, and Q.55.

Bingera Mill Area.

Atlas, C.P.29/116, Co.290, Pindar, P.O.J.2878, Q.25, Q.42, Q.47, Q.49, Q.50, Q.55, and Vesta.

Fairymead Mill Area.

C.P.29/116, Co.290, Pindar, P.O.J. 2878, Q.42, Q.47, Q.49, Q.50 and Q.55.

Gin Gin Mill Area.

C.P.29/116, Co.290, Co.301 Mahona, M.1900 Seedling, Pindar, P.O.J.2878, Q.25, Q.42, Q.47, Q.49, Q.50, Q.55, and Vesta.

Isis Mill Area.

C.P.29/116, Co.290, Co.301, Pindar, P.O.J.2878, Q.42, Q.47, Q.49, Q.50, Q.51, and Q.55.

Maryborough Mill Area.

Pialba District.

C.P.29/116, Co.290, Co.301, P.O.J. 213, P.O.J.2878, Q.42, Q.47, Q.49, Q.50, and Q.51.

Maryborough District.

C.P.29/116, Co.290, Co.301, M.1900 Seedling, P.O.J.213, P.O.J.2878, Q.42, Q.47, Q.49, Q.50, and Q.51.

Mount Bauple District.

C.P.29/116, Co.290, M.1900 Seedling, P.O.J.213, P.O.J.2878, Q.42, Q.47, Q.49, Q.50, and Q.51.

Moreton Mill Area.

C.P.29/116, Pindar, Q.28, Q.42, Q.47, Q.50, and Vesta.

Rocky Point Mill Area.

C.P.29/116, Co.290, N.Co.310, P.O.J. 2878, Q.28, Q.47, Q.49, Q.50, Q.813, Trojan, and Vesta.

NORMAN J. KING,
Director of Sugar Experiment Stations.

Approved Fodder Canes

Bureau of Sugar Experiment Stations, Brisbane, 1st January, 1953.

All farmers are advised that the following are the varieties of cane which may be grown for fodder purposes in the sugar mill areas as set out below:—

Mossman, Hambledon, Mulgrave, Babinda, Goondi, South Johnstone, Mourilyan, Tully, Victoria, Macknade, Invicta, Pioneer, Kalamia, and Inkerman Mill Areas.

China, Uba, Co.290, "Improved Fodder Cane," and Co.301.

Proserpine, Cattle Creek, Racecourse, Farleigh, North Eton, Marian, Pleystowe, and Plane Creek Mill Areas.

China, Uba, "Improved Fodder Cane," and Co.301.

Qunaba, Millaquin, Bingera, Fairymead, Gin Gin, Isis, Maryborough, Mount Bauple, Moreton, and Rocky Point Mill Areas.

China, 90 Stalk, "Improved Fodder Cane," C.S.R 1 (also known as E.G.), and Co.301.

NORMAN J. KING,
Director of Sugar Experiment Stations.

How the Other Half Works

It is always of interest to the Queensland cane grower to know how his counterpart in other countries grows his crop. A recent report from the Department of Agriculture in Mysore, India, contains the following notes on manuring for sugar cane crops:

"(1) Plough in 6 to 10 cart-loads of green manure per acre not earlier than 20 days and not later than 25 days before planting. It would be an advantage if the green manure crop is grown *in situ:* a mixture of sunnhemp and cowpea would suit the purpose.

(2) A fortnight later, *i.e.*, five to seven days before planting, spread evenly not less than 20 cart-loads of farmyard manure per acre and mix thoroughly with soil by shallow ploughing or passing the cultivator. In case of pit planting, apply at least four to five baskets of cattle manure to each pit.

(3) Apply at planting a mixture of 2 cwts. of sulphate of ammonia, $1\frac{1}{2}$ cwts. of concentrated supers and 1 cwt. of sulphate of potash per acre in the newly opened up furrows or pits and cover the mixture with a thin layer of soil. Irrigate lightly and plant cane setts, taking care that the eye buds do not come in direct contact with the fertilizer mixture (sulphate of potash may be omitted where cane is grown only occasionally).

(4) Earth up the young crop lightly six weeks after planting after applying, if available, 5 tons of compost or half a ton of cake mixture.

(5) Apply 1 cwt. of sulphate of ammonia twelve weeks from planting.

(6) Thirteen to fourteen weeks from planting, earth up the crop finally after applying three tons of compost if available or half a ton of groundnut cake or mixture of oil cakes.

The whole of the farmyard manure may be advantageously replaced by compost, compost to farmyard manure being in the proportion 1 : 3."

The system involves the usage of $5\frac{1}{2}$ cwt. of fertilizer, plus eight tons of compost (or 1 ton of oil cake) and 20 cart-loads of farmyard manure per acre. This is in addition to the green manure previously ploughed into the soil. The amount of fertilizer is not high, but the other dressings emphasize the value which is placed on organic manures in that country. Cheap labour, both for preparation of compost and for spreading in the field is, of course, the ruling factor in such a cultivation system. This and the presence of large numbers of stock makes possible in Mysore a farm routine which could not be considered in a high-wage, mechanized industry.

N.J.K.